

WAR DEPARTMENT
TECHNICAL MANUAL

TM 11-2005

REPEATER SET

TC - 19

(INTERMEDIATE)

WAR DEPARTMENT UNSATISFACTORY EQUIPMENT REPORT

(Technical service)		DATE
FOR		MATERIEL
FROM	(Organization)	(Station)
TO	(Next superior headquarters)	(Station)
		(Technical service)

COMPLETE MAJOR ITEM		
NOMENCLATURE	TYPE	
MODEL	MANUFACTURER	
U. S. A. REG. NO.	SERIAL NO.	DATE RECEIVED
EQUIPMENT WITH WHICH USED (IF APPLICABLE)		

NOMENCLATURE OF DEFECTIVE COMPONENT	
PART NO.	TYPE
MANUFACTURER	DATE INSTALLED

LENGTH OF SERVICE							
DATE OF INITIAL TROUBLE		TOTAL PERIOD OF OPERATION BEFORE FAILURE (FILL IN WHERE APPLICABLE)					
		YEARS	MONTHS	DAYS	HOURS	MILES	ROUNDS
TOTAL		YEARS	MONTHS	DAYS			
TIME INSTALLED							

DESCRIPTION OF TROUBLE AND PROBABLE CAUSE
GIVE TYPE OF FAILURE. MECHANICAL, ELECTRICAL, WORKMANSHIP, MATERIAL, DESIGN

UNUSUAL SERVICE CONDITIONS			
GIVE BRIEF DESCRIPTION			
TRAINING OR SKILL OF USING PERSONNEL (CHECK ONE)		POOR	FAIR
DESCRIPTION OF ANY REMEDIAL ACTION TAKEN		GOOD	

1ST IND.			ORIGINATING OFFICER	
OFFICE	STATION	DATE	SIGNATURE	
(Technical service)			NAME	
TO CHIEF NAME STATION			RANK AND TITLE	
			ORGANIZATION	

- ### INSTRUCTIONS
1. It is imperative that the Chief of Technical Service concerned be advised at the earliest practical moment of any constructional, design, or operational defect in matériel. This form is designed to facilitate such reports and to provide a uniform method of submitting the required data.
 2. This form will be used for reporting manufacturing, design or operational defects in matériel with a view to improving and correcting such defects, and for use in recommending modifications of matériel.
 3. This form will not be used for reporting failures, isolated material defects or malfunctions of matériel resulting from fair-wear-and-tear or accidental damage nor for the replacement, repair, or the issue of parts and equipment. It does not replace currently authorized operational or performance records.
 4. Reports of malfunctions and accidents involving ammunition will continue to be submitted as directed in the manner described in AR 750-10 (Change No. 3).
 5. It will not be practicable or desirable in all cases to fill all blank spaces of the report. However, the report should be as complete as possible in order to expedite necessary corrective action. Additional pertinent information not provided for in the blank spaces should be submitted as inclosures to the form. Photographs, sketches or other illustrative material are highly desirable.
 6. When cases arise where it is necessary to communicate with a chief of service in order to assure safety to personnel, more expeditious means of communication are authorized. This form should be used to confirm reports made by more expeditious means.
 7. This form will be made out by using or service organizations and forwarded in duplicate through command channels to the chief of technical service. The office of the chief of technical service receiving the report will forward an information copy to the Commanding General, Army Ground Forces or Army Air Forces, whichever is applicable, and to the Commanding General, Army Service Forces.
 8. Necessity for using this form will be determined by the using or service troops.

WAR DEPARTMENT TECHNICAL MANUAL

TM 11-2005

REPEATER SET TC-19

(INTERMEDIATE)

WAR DEPARTMENT,
WASHINGTON 25, D. C., 30 OCTOBER 1943.

TM 11-2005, Repeater Set TC-19, is published for the information and guidance of all concerned.

[A. G. 300.7 (19 October 1943).]

By order of the Secretary of War:

G. C. MARSHALL,
Chief of Staff.

OFFICIAL:

J. A. ULIO,
Major General,
The Adjutant General.

DISTRIBUTION: IC 11(5)

(For explanation of symbols see FM 21-6.)

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DESTRUCTION NOTICE

WHY: To prevent the enemy from using or salvaging this equipment for his benefit.

WHEN: When ordered by your commander, or when you are in immediate danger of capture.

HOW: 1. Smash. Use sledges, axes, hand-axes, pick-axes, hammers, crowbars, heavy tools, etc.
2. Cut. Use axes, hand-axes, machetes, etc.
3. Burn. Use gasoline, kerosene, oil, flame-throwers, incendiary grenades, etc.
4. Explosives. Use firearms, grenades, TNT, etc.
5. Disposal. Bury in slit trenches, fox-holes, other holes.
6. USE ANYTHING IMMEDIATELY AVAILABLE FOR DESTRUCTION OF THIS EQUIPMENT.

WHAT: 1. Smash. Open carrying case cover, open panels. Smash relays, meter, resistors, capacitors. Smash framework.
2. Cut. Transformer coil windings, relay windings, all wiring and cables.
3. Bend and/or Break. Frameworks and panels.
4. Burn. Carrying case, manuals in cover.
5. Bury or scatter. Any or all of the above pieces after breaking.

DESTROY EVERYTHING

SAFETY NOTICE

IF NECESSARY TO REMOVE THE REPEATER FROM THE CARRYING CASE, DISCONNECT POWER LEADS FROM THE POWER SOURCE. AVOID TOUCHING TERMINALS WITH BARE HANDS WHILE TESTING. ALL TEST LEADS SHOULD BE INSULATED.

NOTICE

USE TEST SET I-193-A FOR TESTING AND ADJUSTING THE POLAR RELAYS.

REMEMBER THESE POINTS

1. Don't attempt repairs or adjustments on this unit unless you are sure what you're doing.
2. Look for simple causes of trouble first.
3. Do not touch terminals with hands, as high voltages are present.
4. Do not allow one test pick to touch two metal parts at the same time because dangerous short circuits may occur.
5. Keep the inside of your unit dry.
6. This unit is easy to use. Keep it in shape. Have this book handy. It may help you out of a tough spot.

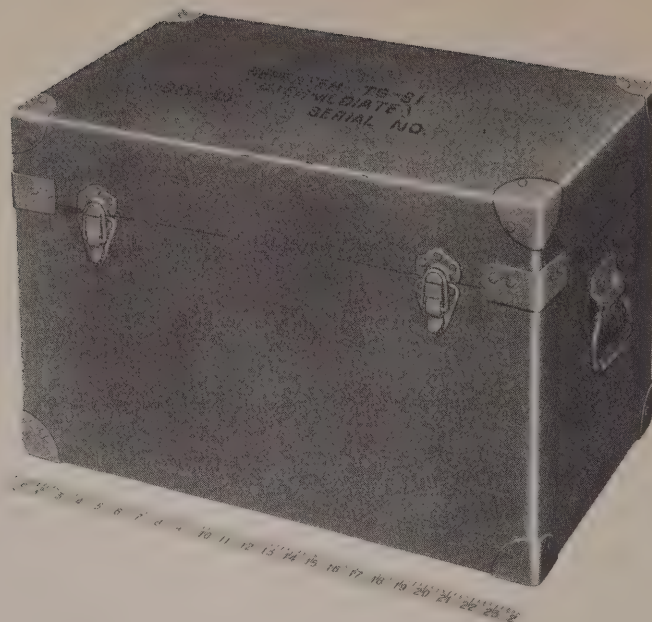


Figure 1 - Repeater TG-31 (Intermediate),
ready for transit

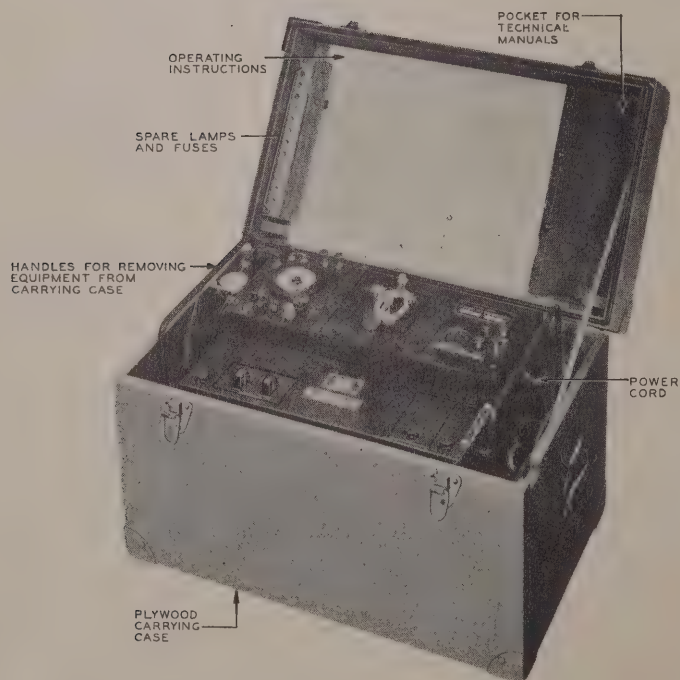


Figure 2 - Repeater TG-31 (Intermediate),
carrying case open for service

SECTION I

DESCRIPTION

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1. PURPOSE.—a. General.—Repeater Set TC-19 (Intermediate) consists of two Ground Rods GP-29 and one Repeater TG-31 (Intermediate). The remainder of this manual is concerned with Repeater TG-31 (Intermediate). Repeater TG-31 (Intermediate) is a d-c telegraph repeater for single operation (transmission in either direction but not at the same time) at an intermediate location between terminal repeaters. It employs ground-return line circuits. The distant terminal repeater equipment should be Repeater TG-30 (Terminal) or its equivalent. Repeater TG-31 (Intermediate) is designed for unattended operation as far as service adjustments are concerned. The equipment may be used on printer circuits operating at speeds up to 66 words per minute (404 operations per minute). A monitoring feature is provided for connecting a printer for sending and receiving. The repeater can be used on field-wire line circuits (simplexed) or open-wire circuits (composited or simplexed). The repeater contains a built-in rectifier power-supply unit. A manual telegraph set is built into the repeater equipment for use when printer equipment is not available for service.

b. Line operation.—The line sides of the repeater are arranged to use the type B polarential (differential sending) form of transmission.

c. Local operation.—The local side of the repeater is arranged for operation with a printer or the built-in manual telegraph set.

2. EQUIPMENT ARRANGEMENTS.—The repeater is portable and housed in a durable wooden carrying case which completely encloses all equipment while in transit. (See fig. 1.) The major component parts are a repeater unit

and a rectifier power-supply unit. The apparatus comprising these units is assembled on mounting plates so arranged that the complete assembly may be removed and located on 19-inch relay racks. While in the carrying case, the basic framework is supported on shock-absorbing mountings. Connecting terminals, jacks, switches, keys, fuses (with spares), a potentiometer, and a meter, used in setting up and maintaining service, are conveniently assembled and clearly designated on the face of the equipment. A power receptacle, a sending jack, and a receiving jack are supplied for making connections to a printer either for monitoring through transmission or as a terminal station. A jack for connecting the telephone receiver used with manual telegraph operation and a jack, for connecting a relay test set, are furnished. The repeater, with the carrying case open for service, is shown in figure 2. During periods of unattended service, the cover of the carrying case is closed and the leads are carried through a weatherproof joint between the carrying case and its cover. The repeater employs four polar relays of the same type. A cut feature is provided so that communication can be carried on with either distant terminal in case the line to the other terminal is open. The cover of the carrying case is hinged, and inside the cover is located storage space for spare fuses, spare neon lamps, and two of these technical manuals. The telephone receiver and the plug attached to the cord used for manual telegraph operation are held in place by clamps on the side of the unit when not in use. A summary of operating instructions is attached inside the cover. One spare polar relay is located in the compartment with those in use. Spare protector blocks are located in the relay compartment. The equipment is constructed for use over a wide temperature range and for use under tropical conditions. Filters to suppress induction from power lines are not furnished.

3. POWER.—a. General.—The repeater circuits require 115-volt direct current. This direct current is usually obtained from the built-in rectifier power-supply unit, which converts alternating current to direct current or steps up a 12-volt storage battery supply to 115-volt direct current. The rated output of the rectifier at 115-volt direct current is 200 milliamperes when operating from an a-c source. Rated output is 130 milliamperes when operating from a 12-volt storage battery. Direct current for operating the repeater circuit may also be obtained from a 115-volt d-c source such as a gas-engine power unit or 115-volt dry batteries. The set is operable from the following power sources:

- (1) 95 to 125 volts or 190 to 250 volts, 50- to 60-cycle a-c
(commercial or gas-engine power unit)
- (2) 115 volts d-c (gas-engine Power Unit PE-77-() or equivalent)
- (3) 115 volts d-c (dry batteries)
- (4) 12 volts d-c (storage battery)

A power cord 10 feet long is provided for connection to the sources (1) and (2) on the preceding page, and binding posts are provided for connection of the leads from dry batteries and 12-volt storage batteries. Power switches arrange the repeater and rectifier power-supply unit for operation on the different sources listed above. The voltage of sources of direct current (gas-engine or 115-volt dry batteries) must be regulated externally to the telegraph repeater. The power-supply unit has switches for adjustment of the d-c voltage supplied to the repeater unit when using a-c power sources or 12-volt storage battery. A receptacle is provided for connection of the printer power cord for operation on power sources (1) and (2).

b. Power requirements.—There is no line or local drain on the power supply, when the repeater is idle (marking) and set up for unattended service, other than the drain required for power-supply losses when using power sources (1) and (4). Data regarding alternating current and direct current (gas-engine) power requirements and battery life data are shown in Table I.

TABLE I

Note: This table is based upon average usage except where otherwise explained.

	<u>Repeater</u>	<u>Printer</u>	<u>Total</u>
115 volts or 230 volts a-c	70 watts	120 watts	190 watts
115 volts d-c (gas-engine)	25 watts	90 watts	115 watts
115-volt dry batteries (BA-26 or equivalent)	Battery life at 70F with repeater operating 12 hours a day at 30 words per minute is 4 to 6 days. (Repeater only, no printer.)		

<u>Temperature</u>	<u>Per Cent Battery Life</u>
70F	100
40F	69
32F	48

12-volt storage battery current drains. (Storage battery life is a function of temperature; repeater only, no printer.)

Without Manual Telegraph Set

Idle, Line A and Line B marking.	1.5 amperes
Repeating from Line A to Line B or from Line B to Line A.	2 amperes

With Manual Telegraph Set

Idle, Line A and Line B marking. 1.5 amperes

Sending to Terminal A and to
Terminal B simultaneously. 3 amperes

4. LINE TRANSMISSION FEATURES.—a. General.—The line side of Repeater TG-31 (Intermediate) is designed for type B polarential operation (differential sending only). Telegraph repeaters using the type B polarential principle of transmission do not require service adjustments to compensate for variations in the electrical characteristics of the line due to changes in leakage resistance and grounded capacity as a result of changing weather conditions. Hereafter in this manual, type B polarential will be referred to as polarential.

5. SERVICE APPLICATIONS.—Repeater TG-31 (Intermediate) will provide service in combination with other equipments as follows:

a. Line operation.

- (1) Repeater TG-30 (Terminal).
- (2) Telegraph Terminal CF-2-() (Carrier).
- (3) X-61822 VF Carrier Telegraph System.
- (4) X-61824 D-C Telegraph Repeater.

Note: All equipments must be set up for polarential polar sending to work with Repeater TG-31 (Intermediate).

b. Local operation.

- (1) Printer TG-7-()
- (2) Manual Telegraph Set (part of Repeater TG-31).

6. CUTTING FEATURE.—The cutting feature provides a means of communication with one terminal in case the line facility is open to the other terminal. Two cut keys, one associated with each line section, are employed. When a cut key is operated, the armature of the associated relay is disabled. Through transmission is prevented when either cut key is operated.

7. MANUAL TELEGRAPH SET OPERATION.—A manual telegraph set is built-in to permit a means of communication when printer monitoring equipment is not available or is inoperative. The frequency of the oscillator; that is, the tone heard in the receiver, may be regulated to suit the personnel using it by means of the adjusting knob on the operating panel. A tone in the order of 1000 cycles should generally be satisfactory. The manual telegraph set is inoperative when a printer is connected or when the headset is not connected.

8. LINE PROTECTION.—Carbon block line protectors are incorporated to prevent damage to the equipment in the case of line voltage surges. These blocks have an air gap of about .005 of an inch. One pair of protector blocks is connected to each line binding post of the repeater. Two pairs of spare protectors are supplied.

9. NOISE INFLUENCE ON TELEPHONE CIRCUITS.—Repeater TG-31 (Intermediate) is supplied with a retardation coil in series with each line. This serves as a noise killer to prevent undesirable noise on simplex telephone circuits. An additional noise filter is required on composited circuits to maintain the same noise level as on simplex circuits. This additional line filter should be provided with the composite equipment.

10. RADIO INDUCTION SUPPRESSION.—The wiring to the line terminals, the send and receive PRINTER jacks, and the telegraph key is carried through lead-in filters and the power cord and the PRINTER POWER receptacle is supplied with power-lead filters to reduce interference to nearby radio-receiving equipment. These filters contain low-resistance air-core coils and small by-pass capacitors. The filters are effective in a range from about 200 kilocycles to 18,000 kilocycles.

11. LINE CONDUCTORS AND OPERATING RANGES.—a. Line Conductors.—This repeater is operable on all types of line wires. The following are the more common types of wires:

- (1) Field Wire W-110-B, simplex
- (2) Field Wire W-143, simplex
- (3) 104-mil copper, open-wire line, composited
- (4) 80-mil, 40 per cent copper-steel, open-wire line, composited
- (5) 104-mil, 40 per cent copper-steel, open-wire line, composited

Open-wire circuits may be operated simplex as well as composited. The following operating ranges in Table II are provided as a guide in laying out circuits. They should not be used as the absolute operating ranges under all conditions. The presence of earth potential, power-line induction or ground resistance tend to reduce operating ranges. The distances given herein for operation on field-wire circuits are based on adverse weather conditions with the wire laid on the ground and with a capacity to ground in the order of 0.8 microfarad per mile and leakage to ground of 1/4 megohm per mile. The distances given for open-wire lines are based on a maximum leakage to ground of 1/4 megohm per mile and a maximum leakage of 3-1/2 megohms per mile between the wires of a pair. In case the leakage between wires of a pair is substantially less than 3-1/2 megohms per mile, it may not be possible to use the pair for more than one telegraph circuit.

b. Operating ranges.

TABLE II

GUIDE FOR DETERMINING OPERATING RANGES
 (Refer to par. 5 for nomenclature of equipments)
368 Operations per Minute. See Note A.

	W-110-B	W-143	104 Mil Copper	80 Mil 40% Copper-steel	104 Mil 40% Copper-steel
	<u>Simplex</u>	<u>Simplex</u>	<u>Composited</u>	<u>Composited</u>	<u>Composited</u>
TG-31 to TG-30	40 miles	40 miles	200 miles	50 miles	100 miles
TG-31 to CF-2-()	25 miles	40 miles	Note B	Note B	Note B

Note A - At 404 operations per minute, the operating range for a line section with Repeater TG-31 and Repeater TG-30 is 30 miles on W-110-B wire. The operating ranges for other wires listed above are the same for 368 o.p.m. and 404 o.p.m. At 404 o.p.m. on all wires except W-110-B the range finder of the printer should be set at 50.

Note B - Field wire lines are assumed for d-c extension facilities from carrier telegraph terminals.

Note C - Repeater TG-31 may be operated over a line section to an X-61822 Carrier Telegraph Terminal or an X-61824 D-C Telegraph Repeater.

12. DIMENSIONS AND WEIGHTS.—The over-all dimensions of the carrying case are:

Length - 25 inches

Height - 16 inches

Depth - 14-1/2 inches

The total weight including all spare equipment is 120 pounds. The shipping space required is 3-1/2 cubic feet.

SECTION II

INSTALLATION AND OPERATION

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Power connections for a-c supply or d-c gas-engine power unit with or without printer	16
Operation to distant terminals, each using Repeater TG-30 (Terminal)	17
Operation to distant terminals, one using Telegraph Terminal CF-2-() (Carrier) and other using Repeater TG-30 (Terminal)	18
Operation of monitoring printer	19
Operation of manual telegraph set	20
Operating cut keys	21

13. OPERATING INSTRUCTIONS.—A facsimile of the condensed operating instructions attached inside the cover of each repeater carrying case is shown in figure 14. Line up the equipment for service in the order shown. The information in the following paragraphs supplements that given in the operating instructions of figure 14.

14. GROUND CONNECTIONS.—Since this equipment is for operation on ground-return circuits, the resistance of the connection to the earth is equal in importance to the resistance of the metallic line conductor. Make every effort to obtain the best ground connection available in the area where service is to be established. It is preferable to run a ground lead a few miles (field wire multiplied is satisfactory) to a water-pipe system or well rather than to drive ground rods in soil not well covered with vegetation or in soil apparently dry. Drive ground rods to the full length and drive two rods at least 25 feet apart. Ground rods driven into the earth surrounding the roots of trees frequently result in a satisfactory low-resistance ground connection.

15. POWER CONNECTIONS FOR BATTERY POWER SUPPLIES.—a. General.—Unattended operation is defined as service without supervision by a repeater man or other attendant. Such operations require the use of 115-volt dry batteries or 12-volt storage batteries for the power supply. No provision is made for operation of a printer when using these power supplies. The cover of the equipment should be closed and clamped during unattended operation and the line and ground leads carried through the weatherproof joint between the cover and the case of the equipment. See paragraph 3b, Table I, for battery life data. The condition of the batteries should be checked before starting

service. All batteries should be covered to prevent the accumulation of moisture on the terminals.

b. Grounding repeater.—Connect a ground wire to the GND binding post (see par. 14).

c. Line-wire connections.—Connect the line wires to LINE A and LINE B binding posts.

d. Using 115-volt dry batteries.—The dry batteries may be 45-volt B batteries, BA-26, or equivalent. Connect three batteries in series. Throw the power switch on the repeater unit to the 115V D-C position. Connect batteries to the 115V DRY BAT terminals (positive and negative as designated). Make all battery connections secure. Hold down MEAS VOLTS key and, if the batteries are new, the voltage will be about 135 to 140 volts. This voltage is higher than the required 115 volts but will give satisfactory operation. Remove batteries when voltage drops to 35 volts for each battery or a total of 105 volts. Connecting two banks of batteries in parallel more than doubles the life of one bank of batteries. The power cord plug must not be connected when using these batteries.

e. Using 12-volt storage battery.—One 12-volt Storage Battery BB-46, or preferably, two 6-volt Batteries BB-55 connected in series, or equivalents may be used. Two 6-volt batteries may be used in series. Connecting two banks of batteries in parallel more than doubles the life obtained from a single bank of batteries. Open door on right-hand side of rectifier power-supply unit panel and throw right-hand toggle switch to 12V STORAGE BAT position. Throw power switch on repeater unit to the position designated 115V OR 230V AC OR 12V DC. Connect storage battery leads according to positive and negative terminal designations to 12V STORAGE BAT terminals. Each lead should be at least no. 14 wire and not more than 4 feet long. Turn ADJUST VOLTS knobs COARSE and FINE until meter reads 127 volts while holding down MEAS VOLTS key. Check voltage during service periods and remove batteries when it is impossible to obtain a voltage of 115 with ADJUST VOLTS knobs in the extreme counterclockwise (to the left) position.

16. POWER CONNECTIONS FOR A-C SUPPLY OR D-C GAS-ENGINE POWER UNIT WITH OR WITHOUT PRINTER.—a. General.—When a printer is used the required power supply is 115 volts or 230 volts a-c 50 to 60 cycles, or 115 volts d-c (gas-engine). Check reliability of power supply and connect ground wire and line wires as covered by paragraphs 15b and c.

b. With 115-volt a-c power supply.—Open door at right-hand side of rectifier panel and throw the right-hand toggle switch to 115/230V AC position and throw the left-hand toggle switch to 115V AC position. Throw the power switch on repeater unit to position designated 115V OR 230V AC OR 12V DC.

Connect power cord to the power supply, hold down MEAS VOLTS key and turn ADJUST VOLTS knobs COARSE and FINE until meter indicates 115 volts if printer is connected (see par. 16e) or 127 volts without printer.

c. With 230-volt a-c power supply.—Open door at right-hand side of rectifier panel and throw right-hand switch to 115/230V AC position and throw left-hand toggle switch to 230V AC position. Throw power switch on repeater unit to 115V OR 230V AC OR 12V DC position. Connect power cord to power supply, hold down MEAS VOLTS key and turn ADJUST VOLTS knobs COARSE and FINE until meter indicates 115 volts if printer is connected (see par. 16e) or 127 volts without printer.

d. With 115-volt d-c supply (gas-engine power unit).—Throw power switch on repeater unit to 115V DC position. Connect power cord to output of generator. The voltage output of the generator should be 115 volts as shown on the meter on Repeater TG-31. Repeater TG-31 (Intermediate) is not equipped with a means of adjusting the voltage when using a d-c gas-engine power unit. Hold down MEAS VOLTS key to check voltage and, if meter shows no indication, reverse the plug connected to the generator receptacle. Check the voltage supplied to the repeater by holding down the MEAS VOLTS key with the printer connected and running, if required (see par. 16e). Adjust and maintain voltage at 115 during service periods by means of controls on the gas-engine power unit.

e. Connecting printer.—Connect the printer cord with the red plug to the PRINTER jack marked RED R. This is the receiving magnet circuit. Connect the printer cord with the black plug to the PRINTER jack marked BLK S. This is the sending contacts circuit. Connect the printer power cord to the receptacle marked PRINTER POWER. This receptacle supplies power to the printer motor. Check to see that the printer range finder is still set in the position determined by the maintenance personnel (usually, between 50 and 55 on the scale).

17. OPERATION TO DISTANT TERMINALS, EACH USING REPEATER TG-30 (TERMINAL) (FIG. 3).—The distant Repeaters TG-30 at terminal A and terminal B should be arranged as polar-sending repeaters (LINE switch in position 1). The line current should be adjusted at both terminal repeaters. At the Intermediate Repeater TG-31, no adjustments other than voltage adjustments are required. Connect the ground lead, the line wires, and the power cord or leads. Then throw power switches, and adjust the voltage as covered in paragraphs 14, 15, and 16. When the power supply is alternating current or 115 volts d-c (gas-engine power unit), a printer may be employed as covered in paragraph 16e.

18. OPERATION TO DISTANT TERMINALS, ONE USING TELEGRAPH TERMINAL CF-2-() (CARRIER) AND OTHER USING REPEATER TG-30 (TERMINAL) (FIG. 4).—At Telegraph Terminal CF-2-() (Carrier), turn the LOOP switch to the POLARENTIAL - HALF DX

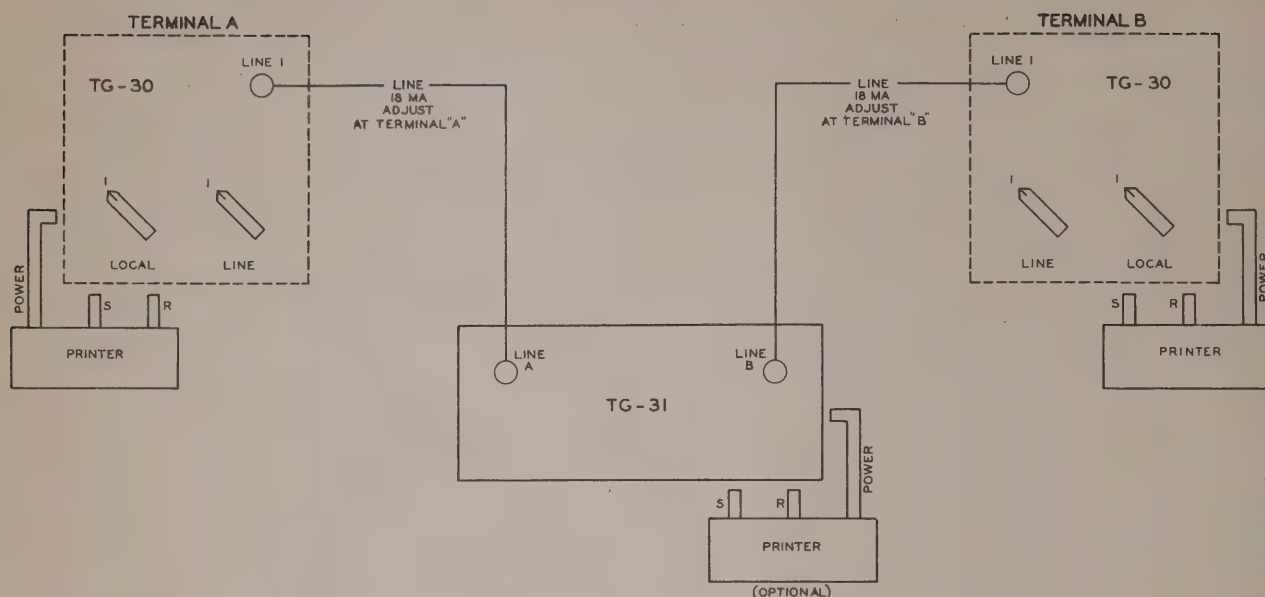


Figure 3 - Operation with Repeaters TG-30 at distant terminals

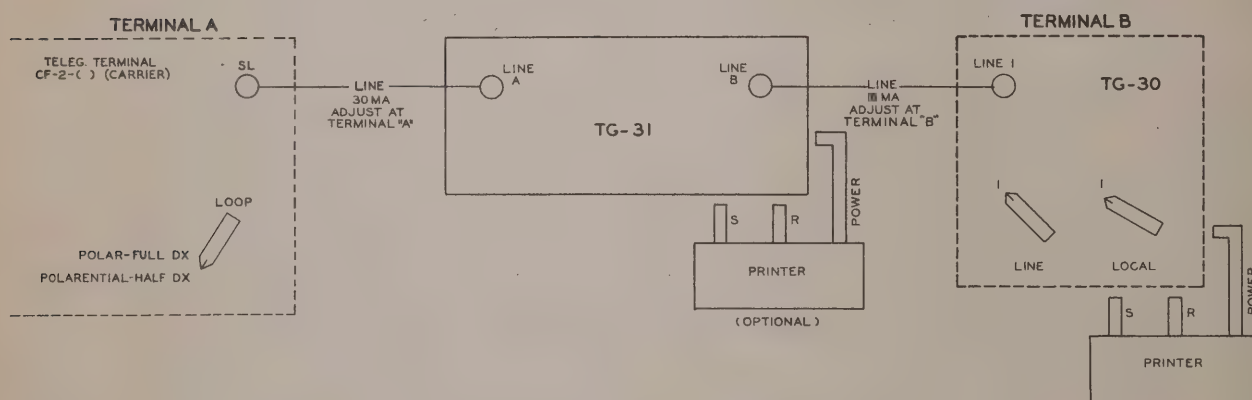


Figure 4 - Operation with a Telegraph Terminal CF-2-() (Carrier) and a terminal using Repeater TG-30

position and connect the line wire to binding post SL. Adjust the line current to 30 MA marking at the carrier terminal. At the Intermediate Repeater TG-31, connect the ground lead, the line wires, and the power cord or leads. Then throw the power switches and adjust the voltage as covered in paragraphs 14, 15, and 16. When the power source is alternating current or a 115-volt d-c (gas-engine) supply, a printer may be used and connected as in paragraph 16e. At the Repeater TG-30, the LINE switch should be turned to

position 1 (polar sending) and the line wire connected to the LINE 1 binding post. Adjust the line current at Repeater TG-30. The LOCAL switch on Repeater TG-30 should be turned to suit the form of local operation employed; position 1, for example, if a printer is required.

19. OPERATION OF MONITORING PRINTER.—When the printer has been connected as described in paragraph 16e, operation of its keyboard sends to both distant terminals and makes a local copy at the intermediate repeater. The printer will print a local copy of transmissions passing through from either distant terminal.

20. OPERATION OF MANUAL TELEGRAPH SET.—To operate the manual telegraph set remove all the printer cords and connect the telephone receiver (headset) cord to the HEADSET jack. Manual telegraph operation uses battery or a-c or gas-engine d-c power supplies. While operating the telegraph key, turn the knob designated ADJ TONE to get a satisfactory tone. When distant terminal is using a printer, send a number of long dashes as a signal that manual telegraph operation is desired. The distant printer will run open while the key is held down. The telegraph key sends to both terminals at the same time and signals from either terminal (one at a time) are received in the headset.

21. OPERATING CUT KEYS.—Check the line to terminal B by turning the knob designated CUT LINE A and try to communicate with terminal B. Return the CUT LINE A knob to its former position. Check the line to terminal A by turning the knob designated CUT LINE B and try to communicate with terminal A. Be sure to restore both the CUT LINE A and CUT LINE B knobs when the circuit is suitable for through service. Turning of the CUT LINE A knob prevents through transmission from line A to line B but not from line B to line A. Turning of this knob also allows sending from the printer keyboard or telegraph key to line A and line B and reception on the printer or in the headset from line B. Turning of the CUT LINE B knob prevents through transmission from B to A but not from A to B, allows sending from the local printer or telegraph key to A and B, and allows reception from line A. Turning of both CUT keys prevents through transmission in both directions and allows sending to both lines at the same time and prevents reception from either line.

SECTION III
FUNCTIONING OF PARTS

	Paragraph
Polarential operation	22
Telegraph polar relay	23
Repeater circuit line operation	24
Monitoring circuit	25
Rectifier power circuit operation	26
Manual telegraph set circuit operation	27

22. POLARENTIAL OPERATION.—Fundamentally, a circuit operating on a polarential basis employs polar transmission in one direction and differential transmission in the other direction. These two terms have been combined to form the word polarential.

a. Polar transmission.—In a polar-transmission system, the marking and spacing line currents are of the same magnitude and flow in opposite directions, and the receiving relay operates on these reversals of line current and hence requires no local bias circuit.

b. Differential transmission.—In a differential transmission system, the marking and spacing line currents are different in magnitude and as applied to the polarential method of operation, the magnitude of the spacing current in one direction of transmission is about 2-1/2 times that of the marking current and flows in the same direction as the marking current. Therefore, a local bias circuit is required at the terminal receiving the differential signals, and by fixing this local bias circuit in a marking direction at half the sum of the received marking and spacing line currents, and poling the line winding of the receiving relay spacing, the net effect on the armature of the receiving relay is equivalent to polar transmission.

c. Complete transmission system.—See figure 5 which shows the theoretical schematic diagram for a system with Repeater TG-31 (Intermediate) and two repeaters similar to Repeater TG-30 (Terminal). The operation over the line A from the Intermediate Repeater TG-31 to Terminal A (TG-30) will be considered. Since the SEND relay of Terminal A applies a negative and a positive polarity of the same value while sending, it is said to be the polar sending end of the circuit and consequently Relay A at the intermediate repeater is said to be in the polar receiving end of the circuit. Since Relay B at the intermediate repeater applies ground for marking and a positive polarity for spacing, it is known as the differential sending end of the circuit and consequently the REC relay at Terminal A is said to be in the differential

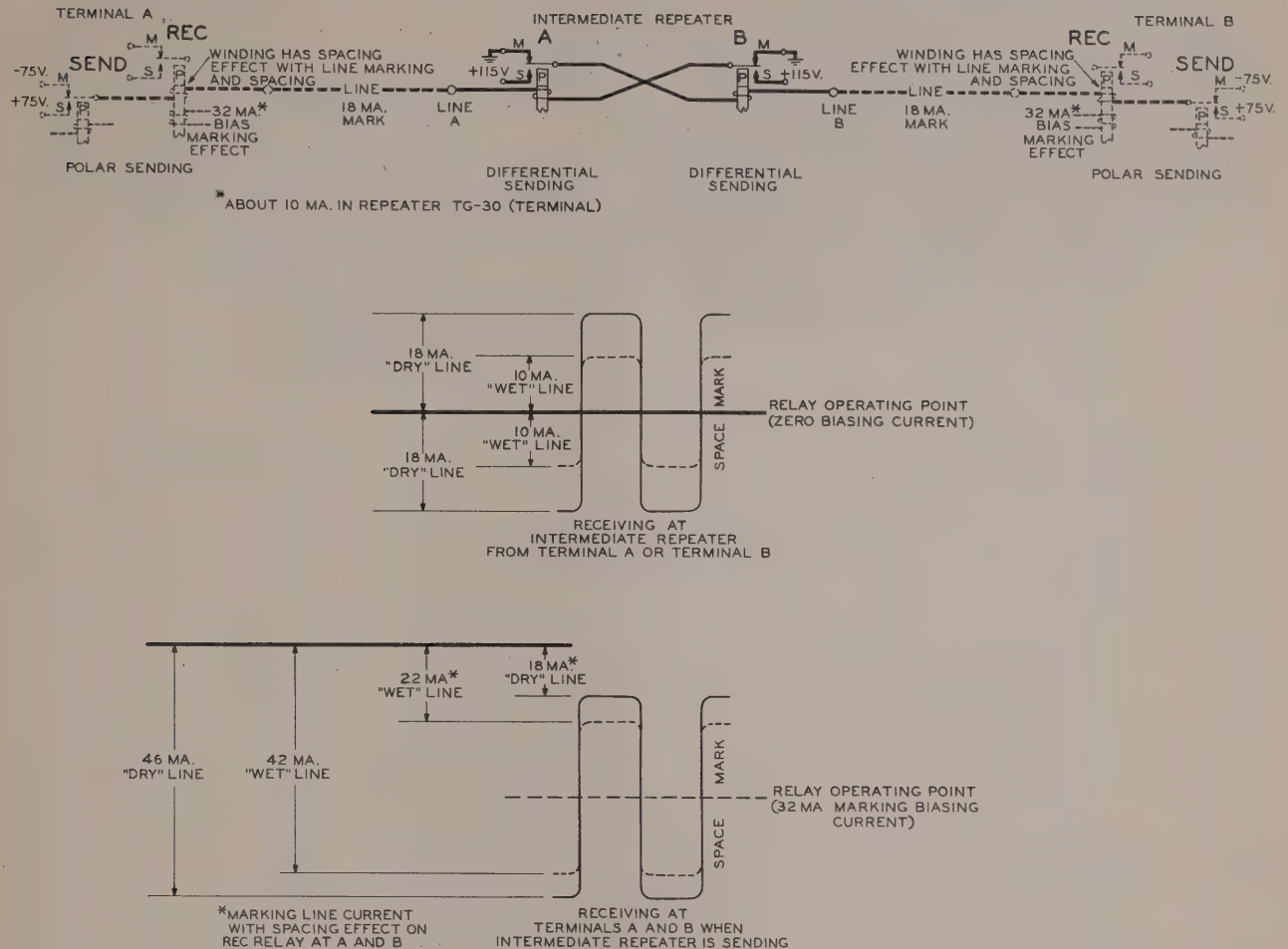
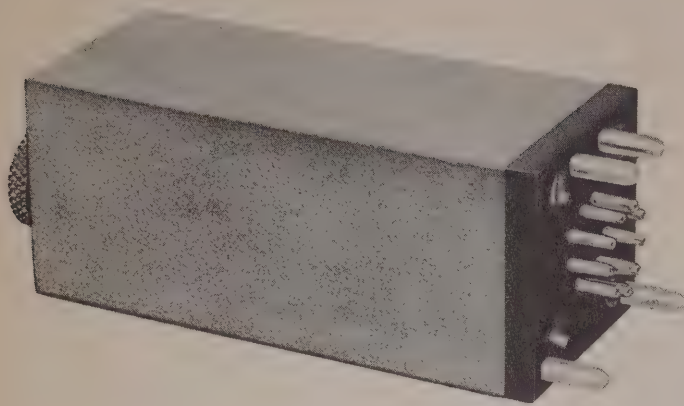


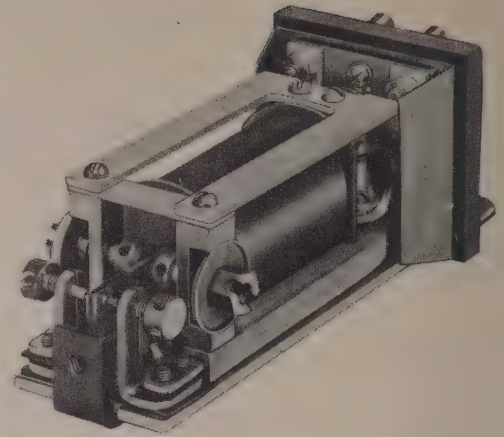
Figure 5 - Theory schematic of polarential operation

receiving end of the circuit. Examples of currents received at each end of the circuit under wet and dry line conditions are also shown in figure 5. A study of these currents will show that the effect of line leakage in wet weather is minimized in both directions of transmission. Operation of the line circuit from Terminal B to the intermediate repeater is similar to that just considered, as the intermediate repeater sends differential signals and receives polar signals in the same way on the line B side as on the line A side. The actual biasing current used on the REC relays in Repeater TG-30 is about one-third of 32 milliamperes shown in figure 5 because the strength of the biasing winding in the receiving relay is three times that of the line winding.

23. TELEGRAPH POLAR RELAY (FIG. 6).—The repeater employs four polar relays of the same type. These are the two line relays and the sending and



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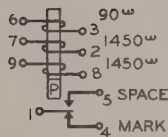


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Figure 6 - Polar Relay D-164816

TURNS RATIO OF

$$\frac{N_{90\omega}}{N_{1450\omega}} = \frac{1}{3}$$



NOTE:
POSITIVE BATTERY CONNECTED TO
TERMINAL 2 OR 3 OR 8 OPERATES ARM-
ATURE 1 TO CONTACT MARK 4.

Figure 7 - Schematic Cir-
cuit of Polar Relay
D-164816

receiving monitoring relays. Western Electric Company's part number for these relays is D-164816. It is a 3-winding relay arranged for mounting in a vacuum-tube socket which serves as a connecting block. The weight of the relay is one pound and one ounce. One winding is a 90-ohm winding and the other two are 1450-ohm windings. Figure 7 is a schematic circuit of the relay. Relay D-164816 is tested and adjusted in TEST SET I-193-A.

24. REPEATER CIRCUIT LINE OPERATION.—a. Main repeating circuits.—Repeater TG-31 (Interme-

diante) is a direct point through repeater; that is, the armature of relay A which receives from line A repeats directly to line B and the armature of relay B which receives from line B repeats directly to line A. The armatures of relay A and relay B supply ground for marking and positive 115 volts for spacing. Refer to figure 8 which is a functional schematic circuit, and to figure 15 which is a detail schematic circuit. The negative side of the power supply or the rectifier power circuit is grounded at the repeater power switch. The protector blocks prevent damage to the equipment in the case of line surges. The FILTER A reduces radiation to nearby radio-receiving equipment and the RET COIL A and the RET COIL B are telephone noise-killer coils for simplex operation. Polar relays A and B are held marking by current through their respective line windings from terminal 3 to terminal 6. The distant terminal repeater must apply a negative voltage to the line for marking.

No local bias circuit is required for relays A or B because the distant terminal repeaters apply a positive voltage to the line for spacing thus reversing the current through the relay line windings.

b. Antikick-off circuits.—Varistor A in combination with capacitor A, resistor S (200 ohms), retardation coil C, resistor A, and windings 2-7 and 8-9 of relay A in parallel constitute an antikick circuit to hold relay A marking when relay B is receiving a spacing signal from line B and retransmitting it to line A. Likewise, varistor B, capacitor B, resistor S (200 ohms), retardation coil D, resistor B, and windings 2-7 and 8-9 of relay B in parallel hold relay B marking when relay A is receiving from line A and retransmitting to line B.

25. MONITORING CIRCUIT.—Receiving relay R and sending relay S are associated with the printer monitoring circuit. Relay R controls operation of the printer selector magnet and it is operated by application of positive battery to the 8-9 and 2-7 windings by the contacts of either relays A or B or S when signals are received from lines A or B or the printer sending contacts. Resistors K, L, and G limit the operating current to the proper value in windings 8-9 and 2-7 of relay R. The selector magnet circuit is composed of contacts of relay R current-limiting resistors P and N and positive 115 volts. The selector magnet current is about 64 milliamperes. Winding 3-6 on relay R is a marking holding, and biasing winding. Relay S is responsive to sending from the sending contacts of the printer. This sending circuit consists of winding 3-6 of relay S and current-limiting resistor H connected to positive 115 volts. The bias circuit of relay S is connected spacing and consists of winding 2-7 with resistor J. When the printer sending and receiving cords are connected, the local circuit for relays R and S are established by contacts of PRINTER jacks R and S. There is no local current drain when these cords are not connected.

26. RECTIFIER POWER CIRCUIT OPERATION.—a. General.—This circuit is shown schematically as part of figure 8 and in detail in figure 16. The repeater-unit power switch in the 115V DC position provides a circuit directly to the repeater circuit from the power cord and from the 115V DRY BAT terminals. In the 115V DC position, the power circuit is disconnected because it has no function when the supply is 115 volts direct current (gas-engine power unit or dry batteries).

b. 12-volt storage battery.—When a 12-volt storage battery is connected to the + and - 12V STORAGE BAT binding posts and the right-hand toggle switch is operated to the 12V STORAGE BAT position, the vibrator-type frequency generator G functions to provide a pulsating voltage to the transformer primary winding 5-6-7. The midpoint of this winding is connected through retardation coil L2 to the negative battery polarity. Capacitor E

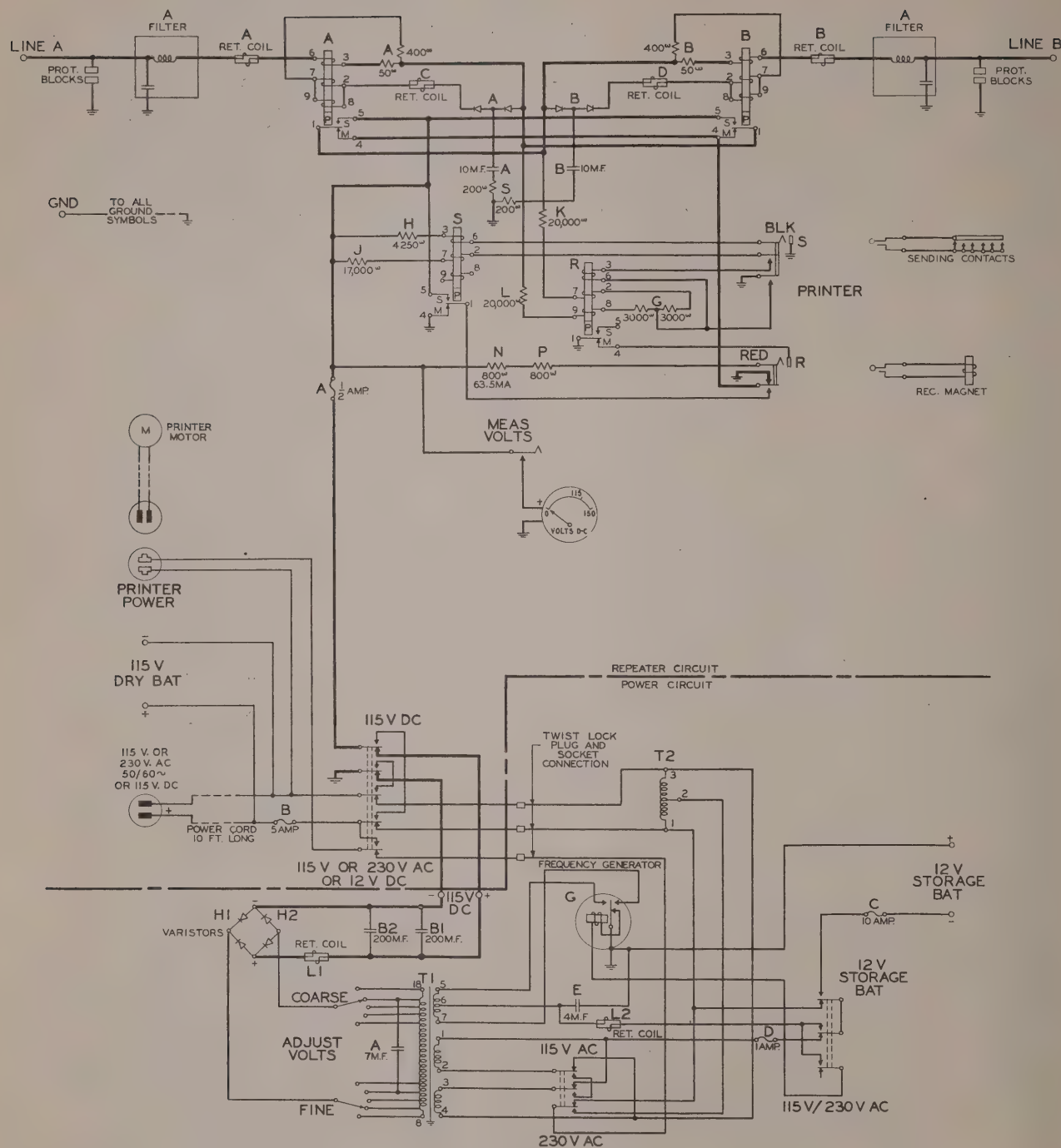


Figure 8 - Functional schematic, repeater circuit with printer and power circuit

is in parallel with the frequency generator. The function of the retardation coil and the capacitor is to improve the frequency-generator voltage wave at the output of transformer T1. The positive side of the battery supply is connected by the frequency generator first to one end of the winding and then to the other end resulting in a pulsating voltage input to the coil and an a-c output voltage from the transformer secondary winding. Capacitor C connected across the battery terminals prevents any radio-frequency current from flowing out of the rectifier circuit over the battery input leads.

c. Alternating current.—When alternating current is connected to the input socket and the right-hand toggle switch (SW1) is operated to the 115/230V AC position, the power is connected through the left-hand toggle switch (SW2) to the primary of transformer T1. When the switch (SW2) is operated to the 115V AC position, primary windings 1-2 and 3-4 are connected in parallel for 115-volt operation. When the switch (SW2) is operated towards the 230V AC position these windings are connected in series for 230-volt operation.

d. D-c output control.—The secondary of transformer T1 is provided with tap leads which are brought out to two ADJUST VOLTS rotary switches so that a tap can be selected as required to give required output from the rectifier. Switch COARSE causes relatively large changes in output voltage and switch FINE causes small voltage changes. Varistors H1 and H2 provide full-wave rectification. It is a selenium disc-type rectifying unit with its output filtered by retardation coil L1 and capacitors B1 and B2 whose combined capacity is 400 microfarads. Capacitor A connected across secondary taps of transformer T1, stores energy during the pulsing of the frequency-generator contacts to provide a voltage wave in the transformer windings similar to the wave when operating from an a-c power supply. This connection provides nearly the same output voltage when operating on alternating current or 12-volt storage battery and also results in the minimum sparking at the frequency-generator contacts.

e. 115-volt a-c output.—When the supply voltage is 230 volts, the autotransformer T2 (winding 1-2) provides a 115-volt a-c supply for the printer motor.

27. MANUAL TELEGRAPH SET CIRCUIT OPERATION (FIG. 9).—The manual telegraph set circuit makes use of the repeater circuit as regards the line receiving-relay functions. The telegraph key is a pole-changer key and it applies ground for marking and positive 115 volts for spacing via the line windings of relay A and relay B in the same manner as relay A or relay B sends to the line. Relay R follows the sending from the telegraph key and produces a local signal. The manual telegraph circuit becomes operative when the headset is connected to the HEADSET jack and the printer cords are removed. The tone is produced by an oscillating circuit consisting of a

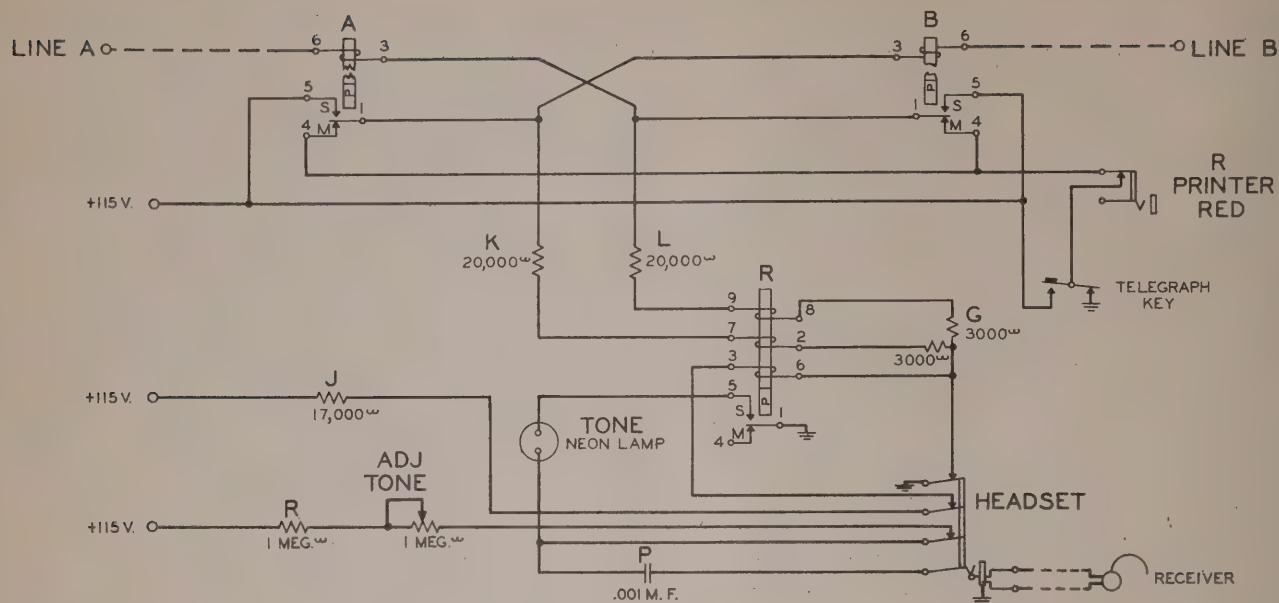


Figure 9 - Schematic of manual telegraph set,
(Part of Repeater TG-31)

small neon lamp TONE, capacitor P, resistor R, and a one-megohm potentiometer labeled ADJ TONE, in combination with receiver. The frequency is adjustable over a wide range by use of the ADJ TONE potentiometer. In the idle or marking condition, the neon lamp does not function. The operation of relay R, resulting from incoming line signals or operation of the telegraph key, applies ground to the neon lamp and causes it to function and produce a tone in the headset.

SECTION IV
MAINTENANCE

	Paragraph
Service tests and inspections	28
Procedure for locating trouble with repeater in service	29
Removing repeater from service	30
Testing facilities and explanation of wiring diagram	31
Locating trouble with repeater removed from service	32
Trouble location	33

28. SERVICE TESTS AND INSPECTIONS.—a. General.—While the repeater equipment continues to function satisfactorily, no maintenance work is necessary other than occasional checks and adjustments of the polar relay (par. 28b), restoration of the film on the electrolytic capacitors in the rectifier power unit (par. 28c), cleaning of the line protector plugs (par. 28d), and replacing the frequency generator (par. 28e).

b. Polar relays and use of Relay Test Set I-193-A.—(1) Polar relays.—The polar relays should be tested and adjusted by using Test Set I-193-A. Operation of this test set and the methods of testing, maintaining, and adjusting polar relays is covered in the technical manual pertaining to Test Set I-193-A. The frequency of relay adjustment is a function of repeater usage. For this reason, it is impractical to establish a specific relay maintenance period. As a guide however, it can be assumed that in constant operation, namely, to-and-fro sending 24 hours a day, a relay should be checked in the test set and adjusted as required about every 30 days. When the service is for a few hours per day, the relay should operate properly for many months. There is no change in the adjustment of the relay while it is idle and connected in a circuit or while it is in storage. To remove the relay from the repeater, turn the relay compartment fasteners in figure 10 counterclockwise, lift the cover and pull the relay straight upward using the knurled thumb screws.

(2) Use of Relay Test Set I-193-A.—The rectifier power unit in Repeater TG-31 may be used as a source of d-c power for operation of the test set. A cord equipped with a gray plug is supplied with Test Set I-193-A for patching to the battery supply TEST SET jack in Repeater TG-31. Connect the tip conductor (white) of this cord to the +BAT, the ring conductor (Blue) to -BAT and the sleeve conductor (Red) to the GND binding post of the test set. Connect ground to the GND binding post of Repeater TG-31 and operate the power switches for the source of power available. Adjust the voltage of the repeater as covered by paragraphs 15 and 16. Any or all relays may be removed from the repeater while it is furnishing power to the test set. See technical manual for Test Set I-193-A for method of operation.

c. Electrolytic capacitors.—Electrolytic capacitors B1 and B2 in the rectifier may lose their film if the equipment is held in storage or if it is operated on a d-c supply for a period of 18 months or longer. These capacitors should be replaced after about 3-1/2 years from the date stamped on the case whether or not the equipment is in service. Normal operation on a-c power will maintain the capacitors in the proper operating condition. To restore the film, connect the power cord of the repeater to an a-c supply for at least 30 minutes every 18 months. If an a-c supply is not available a source of 96-to 120-volts d-c may be connected to the positive and negative output terminals of the rectifier power unit for at least 30 minutes every 18 months with 110/120-volt lamp (25 to 100 watts) in series. The positive side of this lamp circuit should be connected to the +DC terminal and the negative side to the -DC terminal on rectifier power unit terminal block. To make a connection to these terminals, remove the rectifier power unit cover. See figures 11 and 16.

d. Line protectors.—Periodic checks of the line protectors should be made to determine that the carbon blocks are smooth and not pitted and that the assembly is free from dust and dirt. The LINE A, LINE B, and spare protectors are shown in figure 11. The required maintenance period is largely a function of the exposure of the line circuit to high-voltage surges such as lightning. An inspection is recommended after every lightning storm in the area and in any case they should be examined about every 30 days. The protectors are held in place by a flat spring and are readily removed by hand. Do not use pliers or any tool for removing or replacing the blocks. Wipe the carbon block and the porcelain block including the carbon insert with a clean piece of cheesecloth. Discard any blocks which are cracked or pitted or which cannot be wiped smooth. Blocks should not be rubbed together nor should a file or abrasive be employed.

e. Replacing the frequency generator.—The frequency generator G is a completely sealed unit which cannot be serviced or adjusted in the field. Should it fail to function properly, as indicated by excessive noise or by a low-voltage d-c output which cannot be compensated for by the voltage adjusting switches, it should be replaced. A spare frequency generator is furnished in the power unit (fig. 11). Occasionally a frequency generator will fail to start due to dirty or oxidized contact points. If this occurs, remove the power unit cover, tap the generator lightly and in many cases this will start the generator functioning. Then operate the generator for about 1/2 hour to recondition the contact points.

29. PROCEDURE FOR LOCATING TROUBLE WITH REPEATER IN SERVICE.—a. General.—Improper operation may be due to trouble in the repeater unit, the power-supply unit, the printer or the source of power supply. When trouble occurs in service, the following procedure is recommended. This procedure

does not require removing the equipment from the carrying case and utilizes only the meter supplied with the equipment to check voltage and in some cases ordinary 115-volt lamps.

b. Failure to obtain voltage.—Hold down the MEAS VOLTS key and check the voltage. This makes an over-all check of the power source and the power-supply unit in the equipment. Readjust the voltage by use of the voltage adjusting feature on the rectifier power-supply unit, by replacing the dry battery (see par. 15d), or by adjusting the voltage output of the d-c gas-engine power unit. In case no voltage is obtained check all fuses, the power supply and its connection. See fuse table in paragraph 29d. When operating on 115-volt dry battery or 115-volt d-c gas-engine power unit, the meter measures the output voltage of the power source and when operating on a-c or 12-volt storage battery, it measures the d-c output of the rectifier in the power-supply unit. An approximate check of the a-c voltage may be made with 115-volt lamps (two in series on a 230-volt supply) in case an a-c voltmeter is not available.

c. Checking orientation scale setting of printer.—The normal position for the orientation scale pointer is 50 to 55. Only in extreme cases should the orientation of the printer be changed to compensate for improper functioning or improper adjustment of the equipment. A local margin of the printer may be taken by sending from the keyboard and determining the local range without any change in the normal setup of Repeater TG-31. The local range, that is, the difference between the high and low readings on the scale should be at least 70 points. RESTORE THE RANGE FINDER to the normal position after taking the local margin.

d. Replacing fuses.—The locations of the fuses referred to in the following table are shown in figures 11 and 12. A spare fuse and fuse holder are provided on the panel for each type of fuse. Additional fuses unmounted are supplied in the fuse and lamp compartment in the cover. To replace a fuse, unscrew the fuse cap and extract the fuse with the cap. Insert the new fuse in the fuse holder and replace the cap.

TABLE III
FUSE CHART

Equipment Designation and Type	Location	Function	Circuit Designation
1/2 AMP Bussman 8AG 1/2	Adjacent to HEADSET jack	Fuses positive supply to repeater circuit	A
5 AMP Bussman MDM5	Adjacent to PRINTER POWER receptacle	Main power-supply fuse	B
10 AMP Bussman 8AG-10 AMP or Littelfuse 8AG-10 AMP (Spl)	Underneath power unit cover near 12-volt storage battery binding post	Protection for 12-volt storage battery-supply circuit	C
1 AMP Bussman 3AG-1 or Littelfuse 1040	Underneath door on right side of power unit cover	Protection for a-c input circuit	D

e. Replacing lamp in manual telegraph set circuit.—The neon lamp oscillator in figure 12 designated TONE should light when the headset is connected and the telegraph key held down. This lamp is not brilliant and in sunlight it is advisable to shade the lamp in order to check its operation. To replace lamp, unscrew the lamp cap and pull out the lamp. Spare lamps are located in the spare lamp and fuse compartment in the cover.

30. REMOVING REPEATER FROM SERVICE.—a. General.—A repeater which cannot be made to function properly by procedures covered in paragraph 29 should be taken out of service and forwarded to a designated location where suitable testing facilities are available.

b. Removing unit from carrying case.—Disconnect all wires and cords. Loosen the four large round-head assembly screws designated in figure 12 which hold the basic framework of the equipment to the carrying case brackets. Lift the unit from the carrying case using the side handles designated in figure 2 and locate on a test bench.

c. Removing rectifier power unit from repeater unit.—After removing the unit from the carrying case, disconnect the twist lock plug connection at the left-hand side of the power unit and disconnect the wires connected to the ± 115 -volt d-c terminals on the terminal strip located at the right-hand side of the power unit. Refer to figure 13. When replacing the positive and negative 115-volt d-c leads refer to color codes shown in the wiring of the circuit in figure 17. Remove the round-head holding screws on each side bracket which mount the power unit to the framework. The power unit may now be removed from the framework.

31. TESTING FACILITIES AND EXPLANATION OF WIRING DIAGRAM.—a. General.—No special testing tools or facilities are required to follow the maintenance procedures outlined. Use Volt-ohmmeter I-166 (part of Test Set I-56-K) or its equivalent to make voltage and resistance measurements. This meter may be used to measure a-c or d-c voltages, resistances, or to check capacitors for short circuits or grounds. Use a meter with approximately the following characteristics.

Voltage range, d-c - 0-15, 0-30, 0-150, and 0-300 volts

Voltage range, a-c - 0-300 volts

Resistance range - - 0 to 1,000,000 ohms

Resistance - - - - - 1000 ohms per volt either a-c or
d-c scale

b. Wiring diagram.—Figure 17 is a wiring diagram of the repeater circuit and figure 18 is a wiring diagram of the rectifier power circuit. In these diagrams, each piece of apparatus has a letter designation corresponding to that shown on the wiring side; that is, the terminal side of each piece

of apparatus. The apparatus is shown as viewed from the wiring side. In these diagrams, each piece of apparatus is arbitrarily assigned a number, and lines called feed lines representing the individual wires are carried a short distance and terminated on a common or base line turning at right angles to the feed lines. These feed lines are marked with the color of the wire and have a number near the base line which is the same as the number of the piece of apparatus to which the other end of the wire is connected. It is not necessary to trace a connection through the common or base line and no provision is made for doing so. By observing the color and identification number, it is possible to trace directly to the other end of the wire. For example, by reference to figure 17 the resistor E numbered 66 has connected to it a wire BR 76. This means a brown wire is connected to 76. Capacitor G which is numbered 76 likewise shows a brown wire 66 BR. Therefore, these are the two ends of the same wire, one end connected to the resistor E and the other end connected to the capacitor G.

32. LOCATING TROUBLE WITH REPEATER REMOVED FROM SERVICE.—a. General.—In locating an unknown trouble, the use of a terminal Repeater TG-30 in combination with intermediate Repeater TG-31 will be useful. The two repeaters may be set up with a dummy line consisting of a resistance of 500 ohms. This dummy line will not provide a means for making transmission measurements because it is not representative of a real line as regards electrical characteristics. The dummy line, however, permits communication between the two repeaters using printers or the manual telegraph sets. See paragraph 33 for TROUBLE LOCATION tables.

33. TROUBLE LOCATION.—a. List of troubles with probable cause when repeater is operating on 115V AC or 230V AC.

Trouble	Probable Cause
No d-c output voltage.	Switch 115V AC - 230V AC or switch 115V/230V AC - 12V STORAGE BAT not properly thrown or not making contact. Blown fuses (A, B, C, or D). Failure of power supply. Open power cord or rectifier wiring. Shorted capacitors A, B1, or B2. Open winding in transformer T1 or retardation coil L1.
Low d-c output voltage.	Low AC line voltage. The 115V AC - 230V AC switch may be on 230V AC position when input is 115 volts AC. Rectifier discs may require replacement.
High d-c output voltage.	High AC line voltage. The 115V AC - 230V AC switch may be on 115V AC position when input is 230 volts AC.

<u>Trouble</u>	<u>Probable Cause</u>
Erratic d-c output voltage.	Loose connection in power cord or in rectifier wiring. Electrolytic capacitors B1 or B2 may require replacement.(par. 28g).

b. List of troubles with probable cause when repeater is operating on 12-volt storage battery.

<u>Trouble</u>	<u>Probable Cause</u>
No d-c output voltage.	The 115V AC - 230V AC switch or the 12V STORAGE BAT - 115/230V AC switch may not be properly thrown or not making contact. Blown fuses (A or C). Frequency generator contacts may be short-circuited. Open power cord or rectifier wiring. Voltage adjusting switches may not be making contact. Short-circuited capacitors A, C, E, B1, or B2. Open winding in transformer T1, retardation coils L1 or L2 or frequency generator G.
Low d-c output voltage.	Storage battery needs recharging. Frequency generator contact points burned or pitted. Rectifier discs need replacing.
Erratic d-c output voltage.	Loose connection in power cord, rectifier wiring, or repeater wiring. Frequency generator contacts burned or pitted.

c. Point-to-point voltages and resistance measurements.—Remove unit from the carrying case. Remove cover of rectifier power unit and the rear plate covering the terminal side of the apparatus. Test values are based on the use of Volt-ohmmeter I-166 or equivalent as a voltmeter or ohmmeter as required for the test involved. See functional schematic circuit figure 8, detail circuit figures 15 and 16, and wiring diagrams figures 17 and 18.

CAUTION: Do not touch terminals with hands, as high voltages are present. Do not allow one test pick to touch two metal parts at the same time because dangerous short circuits may occur. All values in the following table are typical and not absolute. Variation in testing meters, voltages, and resistances may produce results ± 15 per cent from values shown herein except for resistance of polar-relay windings.

<u>Purpose of Test and Preparation</u>	<u>Winding</u>	<u>Resistance Value</u>
(1) To check resistance of windings of polar relay D-164816. Remove relays from repeater. Viewing relay from the terminal pin side as shown in figure 6, the terminal pin just to the right of the top center will be terminal 1. The terminals are numbered consecutively from this point in a clockwise direction to terminal 9.	3-6	90 \pm 9 ohms
	2-7	1450 \pm 145 ohms
	8-9	1450 \pm 145 ohms
Check all terminals for ground-to-relay framework. No terminals should be grounded; and each should indicate infinite resistance to framework.		
(2) To check voltage drops in rectifier power unit when operating on 115-volt a-c input with printer connected to jacks S and R and to the PRINTER POWER receptacle. Connect ground to GND binding post. To each LINE A and LINE B binding post, connect an adjustable resistance box in series with a milliammeter to a source of about 115 volts negative with the positive side grounded. Adjust line current to 18 milliamperes and voltage of Repeater TG-31 to 115 volts.	<u>Voltage Drop Across</u>	<u>Voltage Measurements</u>
	Transformer T2. Terminal 1 to terminal 3.	115 volts a-c
	Transformer T1. Terminal 1 to terminal 4.	115 volts a-c
	Transformer T1. Terminal 8 to terminal 18.	147 volts a-c
	A-c input to varistors H1, H2. Center terminal H1 to center terminal H2.	103 volts a-c
	D-c output of varistors H1, H2. Terminal 1 (+) to terminal 3 (-).	115.15 volts d-c
	Coil L1. Terminal 1 (+) of varistors H1 or H2 to positive 115-volts d-c terminal.	.15 volts d-c
	115 volts d-c (+) and (-) terminals.	115 volts d-c
	A-c input to varistors H1, H2. Center terminal	104 volts a-c

Purpose of Test and Preparation	Voltage Drop Across	Voltage Measurements
(voltage 11.5 at + and - 12V STORAGE BAT terminals). Repeater arranged as in paragraph 33c(2) except printer not connected. Adjust line current to 18 milliamperes and voltage to 127 volts.	H1 to center terminal H2. Voltage applied to frequency generator G. Positive (+) 12V STORAGE BAT terminal to terminal 2 of coil L2.	11.45 volts d-c
	Coil L2. Terminal 1 to terminal 2 of coil L2.	0.05 volts d-c
	115 volts d-c + and - terminals.	127 volts d-c
		<u>D-c Voltage Measurements</u>
(4) To check voltage drop across retardation coils, varistors, and resistors in repeater circuit when in a marking condition. Repeater arranged as in paragraph 33c(2).	Retardation coil A Retardation coil B Resistor J Resistor H Resistor N Resistor P	0.8 volt 0.8 volt 105 volts 110 volts 51 volts 51 volts
(5) To check voltage drop across retardation coils and varistors in repeater circuit. Arrange repeater as in paragraph 33c(2). Send "repeat space" characters from printer keyboard.	Retardation coil C Retardation coil D Varistor A Varistor B	1/2 volt average 1/2 volt average 14 volts average 14 volts average
(6) To check voltage drop of resistors. Arrange repeater as in paragraph 33c(2) except insert a dummy wooden plug in the jack S instead of printer send cord and readjust current in LINE A and LINE B to 45 milliamperes. Voltage under this condition will be about 114 volts.	Resistor K Resistor L Resistor G (each 3000-ohm section) Resistor A (50-ohm section) Resistor A (400-ohm section) Resistor B (50-ohm section) Resistor B (400-ohm section)	92 volts 92 volts 12 volts 2.3 volts 4.5 volts 2.3 volts 4.5 volts

(7) To check capacitor A and 200-ohm section of resistor S connected to capacitor A. Arrange repeater as in paragraph 33c(6). Connect voltmeter from midpoint of varistor A to ground. Remove relay A and meter should read 125 volts. Remove relay B and meter reading should fall gradually to zero. To check capacitor B and 200-ohm section of resistor S connected to capacitor B. Replace relay A and relay B. Remove relay B and meter should read 125 volts. Remove relay A and meter reading should fall gradually to zero. Replace relays.

(8) To check spark killer resistors and capacitors using volt-ohmmeter as an ohmmeter. Remove all relays and disconnect power cord.

Resistors C, D, and E should show a resistance of 3200 ohms total (1600 ohms each side of center tap). Resistor M should measure 1600 ohms. Capacitors C, D, E, F, G, H, and J should show infinite resistance terminal-to-terminal and both terminals-to-ground.

(9) The paragraphs (1) to (8) inclusive deal with the more important pieces of apparatus used in the equipment, and reference should be made to circuit drawings, figures 15 and 16, and wiring diagrams, figures 17 and 18 for values of apparatus not listed above.

SECTION V
SUPPLEMENTARY DATA

	Paragraph
Table of replaceable parts	34
List of manufacturers	35

34. TABLE OF REPLACEABLE PARTS.—a. General.—The reference designations shown in the first column of the table in paragraph 34b correspond to the designations shown in the schematic circuits in figures 15 and 16, and the wiring diagrams in figures 17 and 18. These designations are also stamped on the equipment or on the mounting panel.

b. Table of replaceable parts, repeater unit.

Reference Designation	Sig. C Stock No.	Name and Description	Function	Manufacturer	Manufacturer's Part No.
	4A2131	REPEATER UNIT; TC-31: An intermediate telegraph repeater capable of receiving from one line section and retransmitting to another line section. The distant terminal repeaters should be TC-30 or equivalent. A monitoring feature is provided and permits connection of a printer for sending and receiving. Designed for operation on compressed open wire and simplex field wire with ground return. Contains built-in manual telegraph set.		W. E. Co.	X-61866-B1
-	3Z3329	GROUND ROD, GP-29: $3/8"$ x $1-1/4"$ diameter. (Part of Repeater Set TC-19 (Intermediate).)			
-	4E926	BLOCK, PROTECTOR: $1-1/4"$ x $3/8"$ x $5/32"$ hard carbon block.		W. E. Co.	26
-	4E927	BLOCK, PROTECTOR: $1-1/4"$ x $3/8"$ x $5/16"$ grooved porcelain block provided with carbon insert depressed below surface of porcelain and held in place with fusible cement.	To protect the equipment against line voltage surges. (Two pairs of spare blocks are furnished.)	W. E. Co.	27
A	3DB20-14	CAPACITOR: Fixed, paper, 16 μ f minimum, 20 μ f maximum, 400 v-v d-c, at -40F to +185F ambient temperature, single unit in rectangular metal case $4-23/32"$ high (not including terminals) $4-15/16"$ wide, $1-1/2"$ deep, Avocolor impregnated, four mounting studs on $4"$ x $3/4"$ centers, two screw-type terminals $7/8"$ high, insulated with phenol plastic. Same as B.	Part of antick-off network for relay A.	W. E. Co.	D-166602
B	3DB20-14	CAPACITOR: Same as A.	Part of antick-off network for relay B.	W. E. Co.	D-166602
C	3DB50-8	CAPACITOR: Fixed, 0.5 μ f $\pm 10\%$, paper, oil filled, 400 v-v d-c at -40F to +185F, $3-1/2"$ x $1"$ x $1-1/2"$ rectangular metal case, two mounting studs on $1"$ centers and terminals on same end of case, hermetically sealed. Same as D, E, F, G, H, and J.	Spark killer for the spacing contact of relay A.	W. E. Co.	D-161555
D	3DB50-8	CAPACITOR: Same as C.	Spark killer for marking contact of relay A.	W. E. Co.	D-161555
E	3DB50-8	CAPACITOR: Same as C.	Spark killer for marking contact of relay B.	W. E. Co.	D-161555
F	3DB50-8	CAPACITOR: Same as C.	Spark killer for spacing contact of relay B.	W. E. Co.	D-161555
G	3DB50-8	CAPACITOR: Same as C.	Spark killer for spacing contact of relay S.	W. E. Co.	D-161555
H	3DB50-8	CAPACITOR: Same as C.	Spark killer for marking contact of relay S.	W. E. Co.	D-161555
J	3DB50-8	CAPACITOR: Same as C.	Spark killer for marking contact of relay R.	W. E. Co.	D-161555

Reference Designation	Sig. C Stock No.	Name and Description	Function	Manufacturer	Manufacturer's Part No.
P	3DAL-10L.1	CAPACITOR: Fired, .001 μ f -10% +20%, paper, oil impregnated, 1600 w-v d-c at -40C to +85C, 1-1/16" x 1-1/4", cylindrical tinmed-brass tube, cardboard outer case. 2-1/2" axial wire lead at each end.	Part of manual telegraph set oscillator circuit.	Solar	XT1MW16-.001
-	62L1735	CAP-FILG: Parallel blades, 10 amperes 250v or 15 amperes 125v, rubber body, metal cord grip, 1-9/16" x 1-1/4" over-all.	Power cord plug.	Habbell	9754
-	4E400	CONNECTING BLOCK: 9-prong vacuum tube socket made of molded insulating material and mounted in square metal frame. 1-15/16" x 1-15/16" x 1 1/2" over-all exclusive of terminals.	Holds relays A, B, R, and S, and spare relay; and provides connections to the repeater circuit except for spare relay.	W. E. Co.	D-164882
-	3E4035-14	CORD: 2-conductor, tinsel, 4'-0" long, rubber-covered, cotton braid, P-47 plug at one end, 2" free conductors with 129 cord tips at other end.	Headset cord.	W. E. Co.	D-161768
-	3E7145	CORD: 2-conductor, 18-gauge copper, 10'-0" long, type SJ cordage, rubber-covered conductors in rubber jacket.	Power cord for connecting to a-c power and d-c (gas-engine).	Simplex or equal	SJ-2 conductor 10'-0" long
A	3Z1892-5.1	FILTER: Two retardation coils and two aluminum foil, paper-filled capacitors hermetically sealed in a 3-1/2" x 1-1/2" x 1" rectangular metal case equipped with two mounting studs. 0.6 ampere, 270 w-v d-c -40F to +150F ambient temperature. Same as B, C, and D.	Radio-suppressor filter, line A and line B.	W. E. Co.	D-163039
B	3Z1892-5.1	FILTER: Same as A.	Radio-suppression filter for PRINTER R jack and telegraph key.	W. E. Co.	D-163039
C	3Z1892-5.1	FILTER: Same as A.	Radio-suppression filter for PRINTER R jack.	W. E. Co.	D-163039
D	3Z1892-5.1	FILTER: Same as A.	Radio-suppression filter for PRINTER S jack.	W. E. Co.	D-163039
E	3Z1892-1.3	FILTER: Two retardation coils and one capacitor assembled on a bracket, 3-13/16" x 2-3/16" x 1-15/16" over-all, moisture resistant. Same as F.	Power cord radio-suppression filter.	W. E. Co.	D-162943
F	3Z1892-1.3	FILTER: Same as E.	Printer power receptacle radio-suppression filter.	W. E. Co.	D-162943
A	3Z2595.6	FUSE: 1/2 ampere 250v fuse enclosed in 1/4" x 1" glass tube with nickel-plated caps.	Repeater circuit fuse.	Buss	8AG 1/2

Reference Designation	Sig. C Stock No.	Name and Description	Function	Manufacturer	Manufacturer's Part No.
B	3Z2605.8	FUSE: 5 amperes, slow blow 25v, combination fuse and thermal element enclosed in 9/32" x 1-1/4" glass tube with nickel-plated caps.	Power cord fuse.	Buss	MDM5
-	3Z3285-6	FUSE EXTRACTOR POST: Fuse holder for 8AG type fuses. 7/16" diameter x 2" with 3/8" terminal at end, second terminal at side, cylindrical, molded black bakelite, finger-operated knob, mounts in 1/2" hole in panel.	Holder for fuse A.	Buss	EJM
-	3Z3285-3	FUSE EXTRACTOR POST: Fuse holder for MM type fuses. Same as EJM except 5/8" mounting hole.	Holder for fuse B.	Buss	ECM
HEADSET	4C4903.55C.1	JACK: Tip, sleeve, and three sets of make contacts, fits 2-conductor plug, singly mounted, one mounting lug, 9/16" x 13/16" x 3-15/32" over-all; terminals accommodate two no. 19 B&S wires. Moisture resistant W.E.Co. no. 355C.	Jack for plug on headset cord.	W. E. Co.	D-163718-355C
PRINTER R - RED	4C4260.1	JACK: Tip, sleeve, and one set of transfer contacts, fits 2-conductor plug, singly mounted, one mounting lug, 9/16" x 13/16" x 3-15/32" over-all, tip terminal arranged to accommodate two no. 16 B&S gauge wires, other terminals accommodate two no. 19 B&S gauge wires. Moisture resistant W.E.Co. no. 226C.	For connecting receive cord of printer.	W. E. Co.	D-163718-226C
PRINTER S - BLACK	4C4903.61C.1	JACK: Tip, sleeve, and two sets of make contacts, fits 2-conductor plug, singly mounted, one mounting lug, 9/16" x 13/16" x 3-15/32" over-all, terminals accommodate two no. 19 B&S wires. Moisture resistant W.E.Co. no. 361C.	For connecting send cord of printer.	W. E. Co.	D-163718-361C
TEST SET	2Z523.6	JACK: Tip, ring, sleeve, and two sets of make contacts, fits 3-conductor plug, heavily insulated, singly mounted, one mounting lug, 9/16" x 13/16" x 3-23/64" over-all, terminals accommodate two no. 19 B&S wires. Moisture resistant W.E.Co. no. 285A.	For connecting polar relay test set.	W. E. Co.	D-161891-285A
CUT LINE A	4C5105.52A1	KEY: Turn button, 2-position locking, two sets of transfer contacts, 29/64" diameter x 3-7/8" over-all. Moisture resistant W.E.Co. no. 522A. Same as B.	For cutting A side of the repeater.	W. E. Co.	D-161892A
CUT LINE B	4C5105.52A1	KEY: Same as A.	For cutting B side of the repeater.	W. E. Co.	D-161892A
MEAS VOLTS	4C5105.47A	KEY: Push-button type, nonlocking, one set of make contacts, 9/16" x 13/16" x 3-41/64" over-all, individually mounted, fits 15/32" drilling.	For connecting voltmeter.	W. E. Co.	D-161894A

Reference Designation	Sig. C Stock No.	Name and Description	Function	Manufacturer	Manufacturer's Part No.
POLE CHANGER	3Z3602-4	KEY: Telegraph key, one set of front and back contacts and circuit closing switch, 1-3/4" x 3-1/2" x 5-29/32" over-all, mounted on hard rubber base. Moisture resistant W.E.Co. no. 2A Pole Changer.	Telegraph key.	W. E. Co.	D-165581
TONE	2Z5888	LAMP, (NEON): 1/10 watt, 90v a-c or 65v a-o, 1-3/4" x 9/32" over-all with octagonal base.	Manual telegraph set oscillator. (Two spare lamps are furnished.)	Littel	5122
TONE	2Z5984-B	LAMP HOLDER: Transparent molded cap, black, cylindrical bakelite body, 2-7/8" long, fits 1/2" diameter hole in panel, 2" below and 7/8" above panel.	For neon lamp tone.	Littel	1414
LINE A	3Z286	POST, BINDING: Brass, nickel finish with molded rubber cap slot 1/8" x 5/32", 5/8" diameter x 1-3/4" over-all. Same as LINE B, 115V DRY BAT +, 115V DRY BAT -, and GND.	For connecting line A.	Eby	TM186
LINE B	3Z286	POST, BINDING: Same as LINE A.	For connecting line B.	Eby	TM186
115V DRY BAT +	3Z286	POST, BINDING: Same as LINE A.	For connecting + lead to 115v dry battery.	Eby	TM186
115V DRY BAT -	3Z286	POST, BINDING: Same as LINE A.	For connecting - lead to 115v dry battery.	Eby	TM186
GND	3Z286	POST, BINDING: Same as LINE A.	For connecting ground to repeater.	Eby	TM186
ADJ TONE	2Z7273-2	POTENTIOMETER: One megohm 20%, linear taper, 2 watts at +70F ambient temperature, switch SPST 10 amperes 10v, molded composition, 1-1/16" diameter x 3/4" depth, 3/8" bushing, 3/8" - 32 thread, shaft 0.250" diameter x 2" long.	To adjust tone heard in the receiver of the manual telegraph set.	A-B	J-U1052GR
-	4B5313	PROTECTOR MOUNTING ASSEMBLY: An assembly for holding one no. 26 and one no. 27 protector block. Two terminals extend through the rear for connecting to the line and ground. 1-1/8" x 2-15/16" x 2-17/64" over-all.	To mount the protectors.	W. E. Co.	P-264190
-	2B2109	RECEIVER: Watch-case type, approximately 1100", nickel-plated case, hard rubber cap, diameter 2-27/64", depth 1-11/64".	For listening to manual telegraph signals.	W. E. Co.	509
PRINTER POWER	-	RECEPTACLE: Female-flush motor plug, T slots, diameter 1.593", depth 1.281", oval plate with two 0.203" holes 2.062" apart.	For connecting printer motor power cord.	Hubbell	7332

Table of Replaceable Parts

Reference Designation	Sig. C Stock No.	Name and Description	Function	Manufacturer	Manufacturer's Part No.
A	409156	RELAY: Polarized, jack mounted, three windings, (primary 81 ω to 99 ω , secondary 1305 ω to 1595 ω , tertiary 1305 ω to 1595 ω) permalloy reed-type armature, antichatter contacts, rectangular phenol fibre cover sprayed with two coats of gray enamel finish, 1-5/16" x 1-5/16" x 5-1/16" over-all. Same as B, R, S, and SPARE.	Receives from line A and transmits to line B.	W. E. Co.	D-164816
B	409156	RELAY: Same as A.	Receives from line B and transmits to line A.	W. E. Co.	D-164816
R	409156	RELAY: Same as A.	Receiving relay for monitoring printer.	W. E. Co.	D-164816
S	409156	RELAY: Same as A.	Sending relay for monitoring printer.	W. E. Co.	D-164816
SPARE	409156	RELAY: Same as A.	Spare.	W. E. Co.	D-164816
A	326040-25	RESISTOR: Fixed, 50 ω \pm 1% 1 watt, 400 ω \pm 1% 5 watts, maximum, both windings 5 watts, wire-wound on core of heat-resisting material; flat-type; two windings, three 1-5/32" terminals; 1-1/2" x 13/64" x 4-21/32" over-all. Moisture resistant W.E.Co. no. 19TN. Same as B.	Part of antikick circuit for relay A.	W. E. Co.	D-161700TN
B	326040-25	RESISTOR: Same as A.	Part of antikick circuit for relay B.	W. E. Co.	D-161700TN
C	326160-4	RESISTOR: Same as A except 1600 ω \pm 5% both windings; 5 watts either or both windings. Moisture resistant W.E.Co. no. 19TE. Same as D and E.	Spark killer for relay A.	W. E. Co.	D-161700JE
D	326160-4	RESISTOR: Same as C.	Spark killer for relay B.	W. E. Co.	D-161700JE
E	326160-4	RESISTOR: Same as C.	Spark killer for relay S.	W. E. Co.	D-161700JE
G	326300-30	RESISTOR: Same as A except 3000 ω \pm 1% both windings; 5 watts either or both windings. Moisture resistant W.E.Co. no. 19RP.	Current limiter for windings 2-7 and 8-9 of relay R.	W. E. Co.	D-161700RP
H	326425	RESISTOR: Fixed, 4250 ω \pm 1%, 5 watts, flat-type, wire-wound on core of heat-resisting material. 1-5/32" terminals on 1-5/16" centers, 1-1/2" x 13/64" x 4-21/32" over-all. Moisture resistant W.E.Co. no. 18FS.	Current limiter for winding 3-6 of relay S.	W. E. Co.	D-161699FS
J	326617	RESISTOR: Fixed, 17,000 ω \pm 1%, one watt, cylindrical, wire-wound on bakelite core, phenol fibre outer tube, 1/2" diameter x 1-1/2" long, 2" axial lead at each end.	Current limiter for winding 2-7 of relay S.	W. E. Co.	D-164888A, 17,000 ω

Reference Designation	Sig. C Stock No.	Name and Description	Function	Manufacturer	Manufacturer's Part No.
K	3Z6620-58	RESISTOR: Fixed, 20000 ω \pm 1%, one watt, cylindrical, wire wound on bakelite core, phenol fibre outer tube, 1/2" diameter x 1-1/2" long, 2" axial lead at each end. Same as L.	Current limiter for winding 2-7 of relay R.	W. E. Co.	D-164888A, 20,000 ω
L	3Z6620-58	RESISTOR: Same as K.	Current limiter for winding 8-9 of relay R.	W. E. Co.	D-164888A, 20,000 ω
M	3Z6160-7	RESISTOR: Same as H except 1600 ω \pm 5%. Moisture resistant W.E.Co. no. 18MT.	Spark killer for relay R.	W. E. Co.	D-161699AT
N	3Z6080-28	RESISTOR: Same as H except 800 ω \pm 1%. Moisture resistant W.E.Co. no. 18CF. Same as P.	Current limiter for printer magnet.	W. E. Co.	D-161699CF
P	3Z6080-28	RESISTOR: Same as N.	Same as N.	W. E. Co.	D-161699CF
R	3Z6801-16	RESISTOR: Fixed, one megohm \pm 20%, 1/2 watt, cylindrical, metallized glass tube filament, molded in phenol plastic, 3/16" diameter x 5/8" long, 1-1/2" axial lead at each end.	Part of manual telegraph set oscillator circuit.	W. E. Co.	KS-8058D, one megohm
S	3Z6020-38	RESISTOR: Same as A except 200 ω \pm 5% both windings; 5 watts either or both windings. Moisture resistant W.E.Co. no. 19AJ.	Part of antikick circuit for relays A and B.	W. E. Co.	D-161700AJ
-	2Z9412-8	RESISTOR MOUNTING: 1/16" x 1/4" x 3" over-all, phenol fibre strip equipped with twelve W.E.Co. P-419093 brass, solder-dipped terminals and two "L" shaped mounting brackets with 0.1875" hole in foot for mounting on 3-1/16" centers.	For mounting the resistors J, K, L, and R, and capacitor P.	W. E. Co.	P-263394
A	3C1987-18L	RETARDATION COIL: D-c resistance 45 ω , inductance 2 henrys at 25 cps, single winding, closed-core coils, electromagnetic shield; 1-3/16" x 1-11/16" x 4-1/4" over-all, rectangular metal case, stud mounted. Moistureproofed W.E.Co. no. 307L. Same as B, C, and D.	Noise killer for line A.	W. E. Co.	D-161818L
B	3C1987-18L	RETARDATION COIL: Same as A.	Noise killer for line B.	W. E. Co.	D-161818L
C	3C1987-18L	RETARDATION COIL: Same as A.	Part of antikick circuit for relay A.	W. E. Co.	D-161818L
D	3C1987-18L	RETARDATION COIL: Same as A.	Part of antikick circuit for relay B.	W. E. Co.	D-161818L
115V, 230V AC OR 12V, 115V DC	3Z9903A-3	SWITCH-ASSEMBLY: Approximately 4-1/8" x 1-1/2" x 1/32" steel detail on which are mounted three Rubbell no. 13L3 3-way toggle flush switches.	Repeater power switch.	Rubbell	EL-11334

Reference Designation	Sig. C Stock No.	Name and Description	Function	Manufacturer	Manufacturer's Part No.
-	2Z9405-3	TERMINAL STRIP: Two terminals, screw mounted, 7/8" x 1 3/8" x 1-1/2" bakelite base with four terminal screws.	For attaching the power-supply cord to the repeater unit.	Jones	2-140
A	3H4956-20	VARIATOR: (Blocking valve), twenty selenium discs approximately 1-3/8" diameter assembled on stud. Discs are in two stacks, one of five and the other of fifteen discs. 1-3/8" x 2-1/8" x 4-1/2" over-all. Same as B.	Part of antikick circuit for relay A.	W. E. Co.	KS-9020
B	3H4956-20	VARIATOR: Same as A.	Part of antikick circuit for relay B.	W. E. Co.	KS-9020
V	3F8150-53	VOLTMETER: 0-150v d-c, 150,000 Ω , 3-1/2" flush-type bakelite case, self-contained moving coil, permanent magnet-type, 75 scale divisions, red mark at 115v, accuracy 2% of full-scale deflections, calibrated for use on .090" thick steel panel.	To measure voltage applied to repeater circuits.	W. E. Co.	D-164548

c. Rectifier power unit.

Reference Designation	Sig. C Stock No.	Name and Description	Function	Manufacturer	Manufacturer's Part No.																											
	3RE956-13	<p>POWER UNIT, DISC-TYPE RECTIFIER: This unit is 5" wide, 19" long, and 9-1/4" deep. This rectifier is designed to operate either from a 95-125v or 190-250v a-c line or from a 12v storage battery. The input and output are as follows:</p> <table><tr><th>Input</th><th>D-c Output</th><th>A-c Output</th></tr><tr><th>Volts</th><th>CPS</th><th>Volts</th><th>Amps.</th><th>Amps.</th><th>**</th></tr><tr><td>95-125</td><td>50/60</td><td>115</td><td>.04-0.2</td><td>95-125</td><td>50/60 1.5 2.0</td></tr><tr><td>190-250</td><td>50/60</td><td>115</td><td>.04-0.2</td><td>95-125</td><td>50/60 1.5 2.0</td></tr><tr><td>12</td><td>DC</td><td>115</td><td>.04-0.12</td><td>-</td><td>-</td></tr></table> <p>A frequency generator is provided to obtain 60 cps a-c from the storage battery. A manually-operated toggle switch is used for connecting to the a-c or d-c supply. Another toggle switch is used for connection to the 115v or 250v a-c supply. The output is unregulated and is adjusted to the desired value by two multicontact switches. Filters are provided in the d-c input and d-c output to suppress noise originating in the rectifier. A 3-terminal male flush base is furnished on the rear of the panel for a-c input and output. Binding posts are furnished on front of the panel for 12v battery connections. The 115v d-c output is terminated on a terminal strip under the cover and brought out by leads through a hole in the rear of the panel.</p> <p>*Continuous **Intermittent</p>	Input	D-c Output	A-c Output	Volts	CPS	Volts	Amps.	Amps.	**	95-125	50/60	115	.04-0.2	95-125	50/60 1.5 2.0	190-250	50/60	115	.04-0.2	95-125	50/60 1.5 2.0	12	DC	115	.04-0.12	-	-	Changes 115/250v a-c or 12v d-c into 115 d-c. Also provides 95-125v 50/60 cps. 1.5 amperes continuous, 2 amperes intermittent.	W. E. Co.	X-61E75-A1
Input	D-c Output	A-c Output																														
Volts	CPS	Volts	Amps.	Amps.	**																											
95-125	50/60	115	.04-0.2	95-125	50/60 1.5 2.0																											
190-250	50/60	115	.04-0.2	95-125	50/60 1.5 2.0																											
12	DC	115	.04-0.12	-	-																											
L1	3CL987-24	<p>COIL, RETARDATION: Inductance .07 henrys with 0.6 ampere d-c through winding and 3v 60 cps across winding, d-c resistance winding (1-2) 1.82 maximum at 68F, 1-3/4" x 1-3/4" x 3-1/4" rectangular metal case, shell-type, silicon steel core, flexible leads, mounted by tapped holes, flexible leads, and tapped holes on same 1-3/4" x 1-3/4" side.</p>	Ripple suppression.	W. E. Co.	D-162824																											
L2	3CL987-48	<p>COIL, RETARDATION: Nominal inductance 26 millihenrys at 4.5 amperes, 3-1/2" x 2-1/2" x 1-11/16", rectangular metal case, 15/16" terminals, stud-mounted, shell-type.</p>	Provides proper shape to frequency-generator voltage wave.	W. E. Co.	D-163048																											
A	3DE7-1	<p>CAPACITOR: 7 μf \pm15%, 400 w-v d-c at -40F to +185F ambient temperature, 4-13/32" (not including terminals) x 2-13/32" x 1-15/32" rectangular metal case, hermetically sealed, paper dielectric, Aroclor impregnated, two phenol plastic insulated terminals, four mounting studs.</p>	Causes frequency-generator voltage wave to have proper shape.	W. E. Co.	D-163954																											
B1	3DE200-1	<p>CAPACITOR: Electrolytic, 200 μf, 200 w-v d-c at -50F to +160F ambient temperature, 1-3/8" diameter x 3-1/2" over-all, cylindrical, metal case unidirectional. Same as B2.</p>	Load filter.	W. E. Co.	KS-8678																											

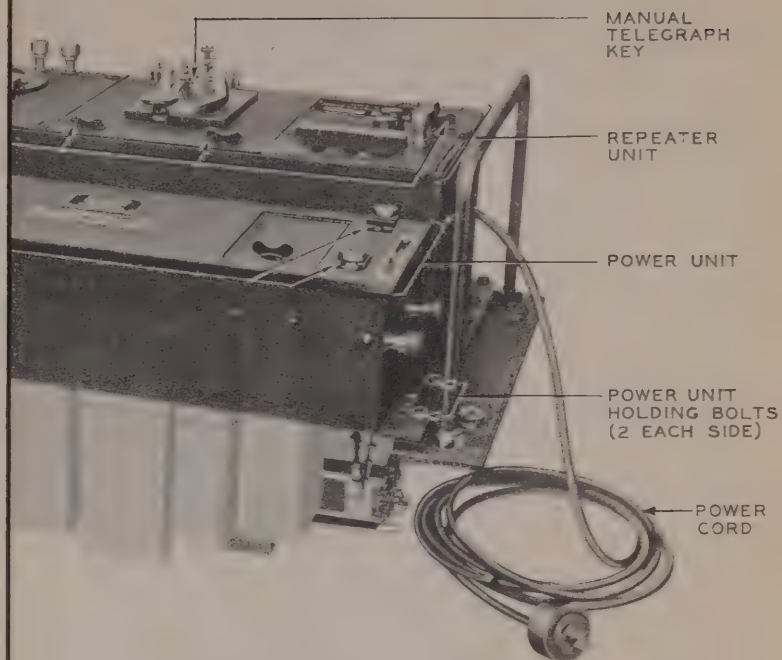
Reference Designation	Sig. C Stock No.	Name and Description	Function	Manufacturer	Manufacturer's Part No.
B2	3DB200-1	CAPACITOR: Same as BL.	Load filter.	W. E. Co.	KS-8678
C	3DA10-158	CAPACITOR: 10,000 μ f $\pm 20\%$, 400 w-v d-c, ambient temperature -40F to +185F, 13/16" x 13/16" x 19/64" thick with 1-5/16" terminals at each end, molded, paper dielectric, mineral oil impregnated.	Radio-frequency filter.	W. E. Co.	404C
E	3DB4-52	CAPACITOR: 4 μ f $\pm 15\%$, 500 w-v d-c at -40F to +150F ambient temperature, 3-29/32" x 1-21/32" x 1-1/2" rectangular metal case, paper, Arcolor filled, sealed, 3/8" mounting studs.	Causes frequency-generator voltage wave to have proper shape.	W. E. Co.	D-162003
-	6Z7591-4	CONNECTOR: (Midget) 10 amperes, 250v or 15 amperes, 125v, 1-1/2" diameter x 1-5/32", 3-wire twist lock connector body, 1/2" cord hole, black bakelite.	Connects a-c input and output cord to rectifier.	Hubbell	7481
C	3Z2610.10	FUSE: 10 amperes, 25v, 1/4" x 1" glass tube with fuse-enclosed, nickel-plated caps.	12v input overcurrent protection.	Buss or Littelfuse	8AG-10 8AG-10 (Special)
D	3Z1926	FUSE: 1 ampere 250v, 1/4" x 1-1/4" glass tube with fuse-enclosed, nickel-plated caps.	A-c input overcurrent protection.	Buss or Littelfuse	3AG-1 1040
G	3H6694	GENERATOR: 60-cycle vibrator for operation on 12v storage battery, 1-5/8" x 2-13/16" cylindrical, 4 prongs 9/16" long, arranged to mount in vacuum-tube socket.	Supplies pulsating current from 12v battery.	W. E. Co.	KS-5566
2Z5822-2	2Z5822-2	KNOB: Bar knob with pointer, black insulating material with white line on pointer, radius 3/4", height 7/8".	Used on switches 212-5 and 212-6.	K-K	S-246-3L
2Z6722	2Z6722	MOUNTING: 2-3/16" x 2-3/16" x 1/16" thick, brown phenol fabric plate with four 0.161" mounting holes symmetrically located, one mounting hole in each corner on 1-7/8" vertical and horizontal centers, punched for mounting capacitor.	Holds capacitor.	W. E. Co.	P-263029
3Z3285-2	3Z3285-2	MOUNTING: Cylindrical, molded black bakelite, 7/16" x 2" with 3/8" terminal at end, second terminal at side, finger-operated knob 11/16" diameter mounts in 1/2" hole in panel, threads on body with nut and neoprene washer for mounting.	Holds fuse.	Buss or Littelfuse	HKM 1075A
3Z286	3Z286	POST, (BINDING): Molded rubber cap 5/8" diameter x 3/8" high, stem 8-32 1-3/8" long, slot 1/8" x 5/32", bottom of base knurled to prevent turning.	12v battery input connection.	Eby	14RC

Reference Designation	Sig. C Stock No.	Name and Description	Function	Manufacturer	Manufacturer's Part No.
	627798-4	RECEPTACLE: (Midset flush) 1" deep x 1.218 diameter with oval mounting plate approximately 2" long, mounting screw holes on 1-5/4" centers, 3-wire, black bakelite, 10 amperes 250v, 15 amperes 125v.	Receives a-c input and a-c output connector.	Hubbell	7486
	228574	SOCKET: Molded bakelite socket for 4-prong vacuum tube arranged for top of panel or subpanel mounting. 2" x 1-5/8" elliptical base 1/4" high, 1-3/8" diameter x 7/16" high, cylindrical part on top of base.	Provides mounting and electrical connections for frequency generator.	W. E. Co.	KS-9203
SW1	329849.25	SWITCH: Toggle, 3-pole, double-throw, 10 amperes 250v, 1-27/32" x 1-3/8" x 2-1/16", one hole mounting, nuts and washers for mounting furnished. Same as SW2.	Provides proper path for each input power supply.	C-H	8666
SW2	329849.25	SWITCH: Same as SW1.	Same as SW1.	C-H	8666
-	32-8300-3	SWITCH: Five taps, rotary motion 120 degrees, 15 amperes 150v, 2-1/4" diameter x 1-7/16" thick with shaft 1/4" diameter x 7/8" long, 3/8", 32-threaded bushing and hexagonal nut for mounting, 1/4" maximum panel thickness.	Adjusts output voltage in large steps.	Ohmite	212-5
-	32-8300-4	SWITCH: Six taps, rotary motion 150 degrees, 15 amperes 150v, 2-1/4" diameter x 1-7/16" thick with 1/4" diameter x 7/8" long shaft, 3/8" threaded bushing and hexagonal nut for mounting, 1/4" maximum panel thickness.	Adjusts output voltage in small steps.	Ohmite	212-6
T1	229620.3	TRANSFORMER: Primary windings (1-2) (3-4) are designed for 50-60 cycles at 95 to 125v when connected in parallel or 190 to 250v when connected in series. Primary winding (5-7) is designed for 57-63 cycles at 22v. With 115v connected to terminals 1 and 2 with 1 connected to 3 and 2 connected to 4 or with 250v connected to 1 and 4 with 2 and 3 connected together or with 22v connected to winding (5-7), the secondary winding (8-18) furnishes 0.5 ampere at approximately 141v at 66% leading power factor. The winding is provided with nine taps so that the voltage may be varied as follows: (8-9) 2v, (8-10) 4v, (8-11) 6v, (8-12) 8v, (8-13) 10v, (8-14) 95v, (8-15) 105v, (8-16) 117v, (8-17) 129v, and (8-18) 141v, 4-9/32" x 4-5/8" x 5-7/16", rectangular, four mounting studs on 2-1/2" x 3-1/2" centers, eighteen 3/8" terminals, electrostatic shield between primary and secondary, moisture resistant.	Changes input voltage to voltage required by rectifier.	W. E. Co.	D-165658

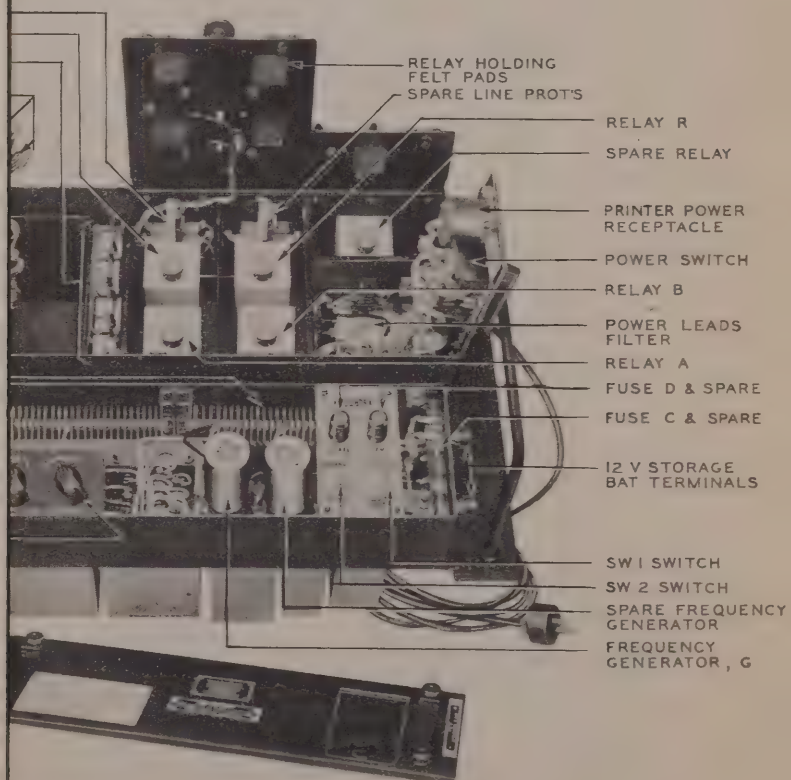
Reference Designation	Sig. C Stock No.	Name and Description	Function	Manufacturer	Manufacturer's Part No.
T2	229620.5	TRANSFORMER: Power autotransformer, input to windings 1-3, 230v 50-60 cycles, output from windings 2-3 1.5 amperes at approximately 115v. Input voltage may be 10% more than rated (230v) voltage, 3-3/4" (not including 3/8" terminals) x 3-1/16" x 4-11/16" rectangular metal case, mounted by four .190"-24 x 1/2" long screws in tapped holes in case, holes on 3-7/16" x 1-7/8" centers, moisture resistant.	Reduces 230v input to 115v for external motor.	W. E. Co.	D-165659
H1		VARISTOR: Full-wave rectifier to work into a capacity filter and deliver 0.2 ampere d-c at 115v into a resistance load with approximately 109v a-c input to rectifier. Temperature range -20F to +130F. Will deliver 0.290 ampere maximum at 130F maximum. Reverse voltage across rectifier should not exceed 130v rms. Two units each comprising eighteen selenium discs approximately 1-3/4" diameter assembled on a stud supported by two mounting brackets, 6-1/4" x 1-3/4" x 2-3/16" over-all. Same as H2.	Rectification.	W. E. Co.	KS-9207
H2		Same as H1.	Same as H1.	W. E. Co.	KS-9207

35. LIST OF MANUFACTURERS.

<u>Abbreviations</u>	<u>Manufacturer</u>	<u>Address</u>
A-B	Allen-Bradley Co.	Milwaukee, Wisc.
Buss	Bussman Manufacturing Co.	St. Louis, Mo.
C-H	Cutler-Hammer, Inc.	Milwaukee, Wisc.
Eby	H. H. Eby, Inc.	Philadelphia, Pa.
Hubbell	Harvey Hubbell, Inc.	Bridgeport, Conn.
Jones	H. B. Jones Co.	Chicago, Ill.
K-K	Kurz-Kasch, Inc.	Dayton, Ohio
Littel	Littelfuse, Inc.	Chicago, Ill.
Ohmite	Ohmite Manufacturing Co.	Chicago, Ill.
Simplex	Simplex Wire & Cable Co.	Boston, Mass.
Solar	Solar Manufacturing Corp.	Bayonne, N. J.
W. E. Co.	Western Electric Co.	New York, N. Y.



er TG-31 (Intermediate), removed
ying case, front view



G-31 (Intermediate), top panels open

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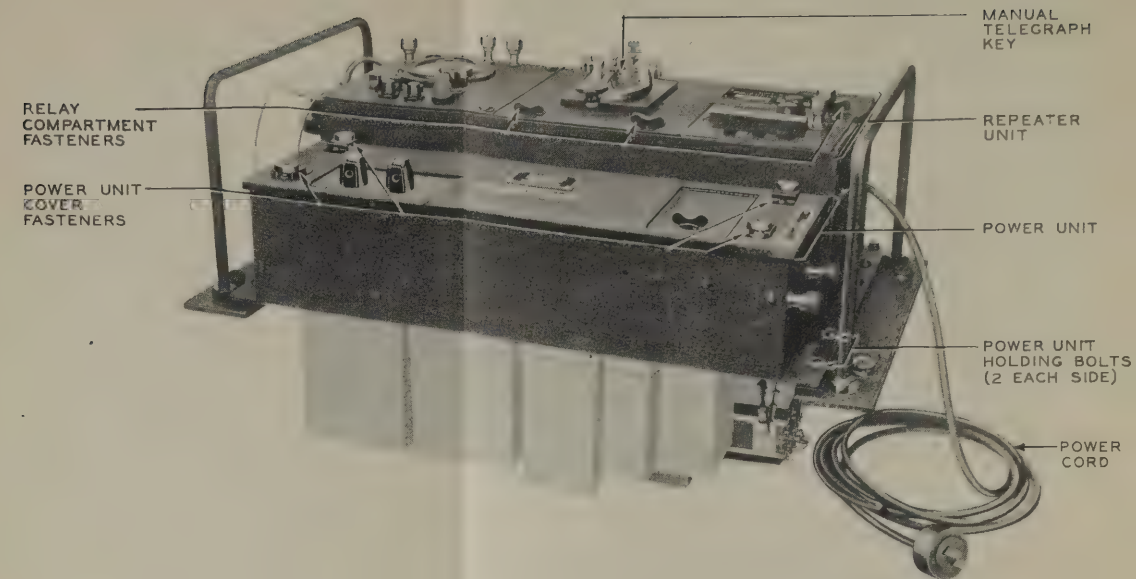


Figure 10 - Repeater TG-31 (Intermediate), removed from carrying case, front view

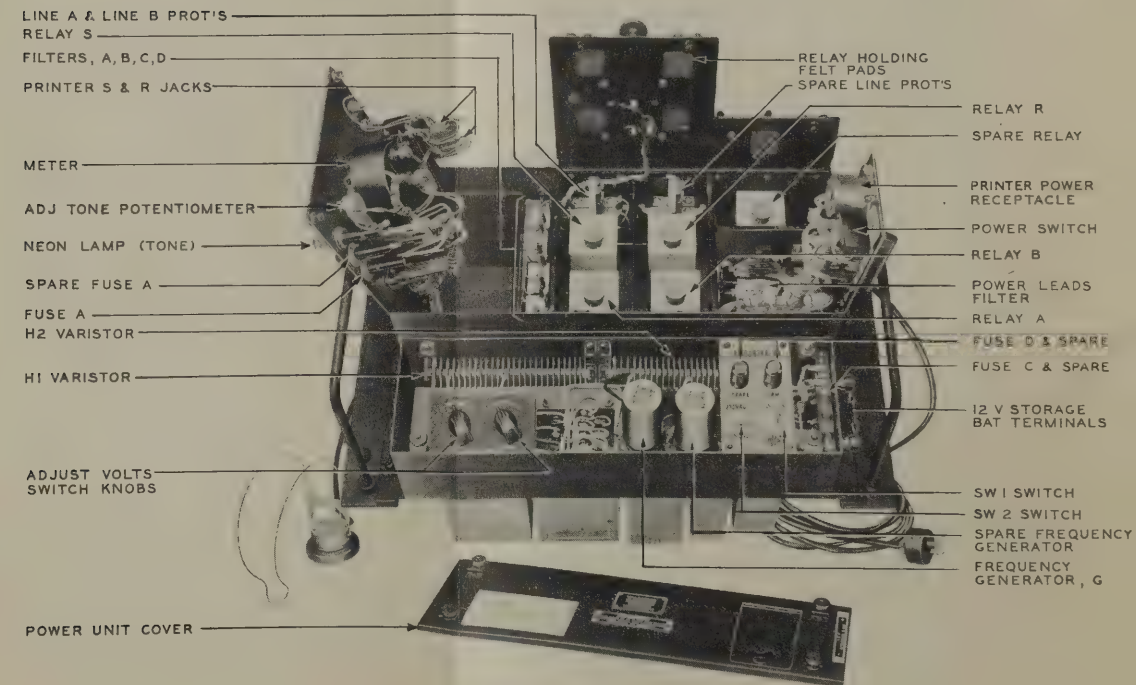


Figure 11 - Repeater TG-31 (Intermediate), top panels open

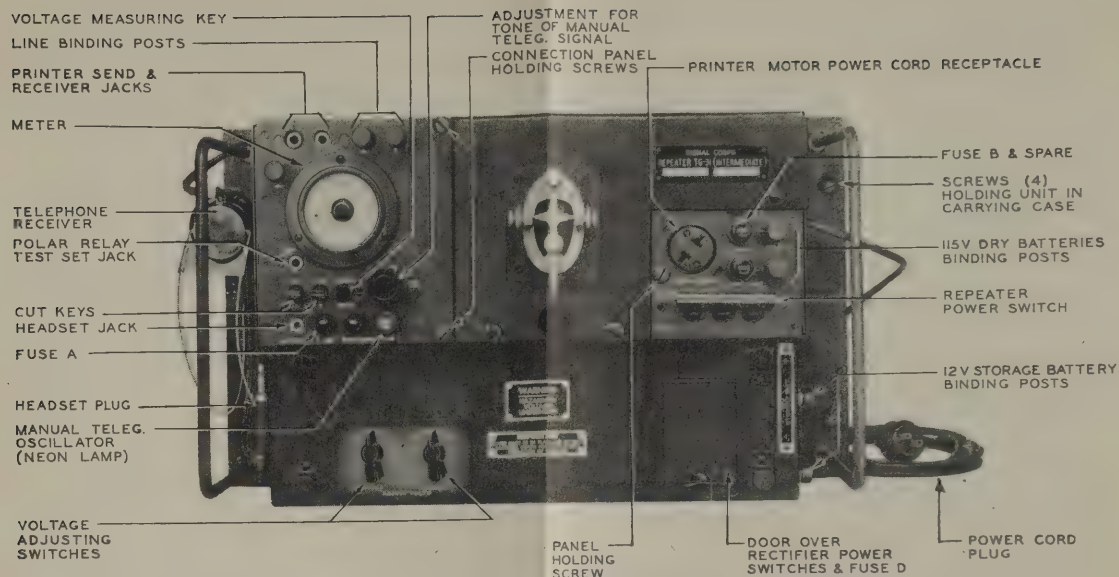


Figure 12 - Repeater TG-31 (Intermediate), removed from carrying case, top view

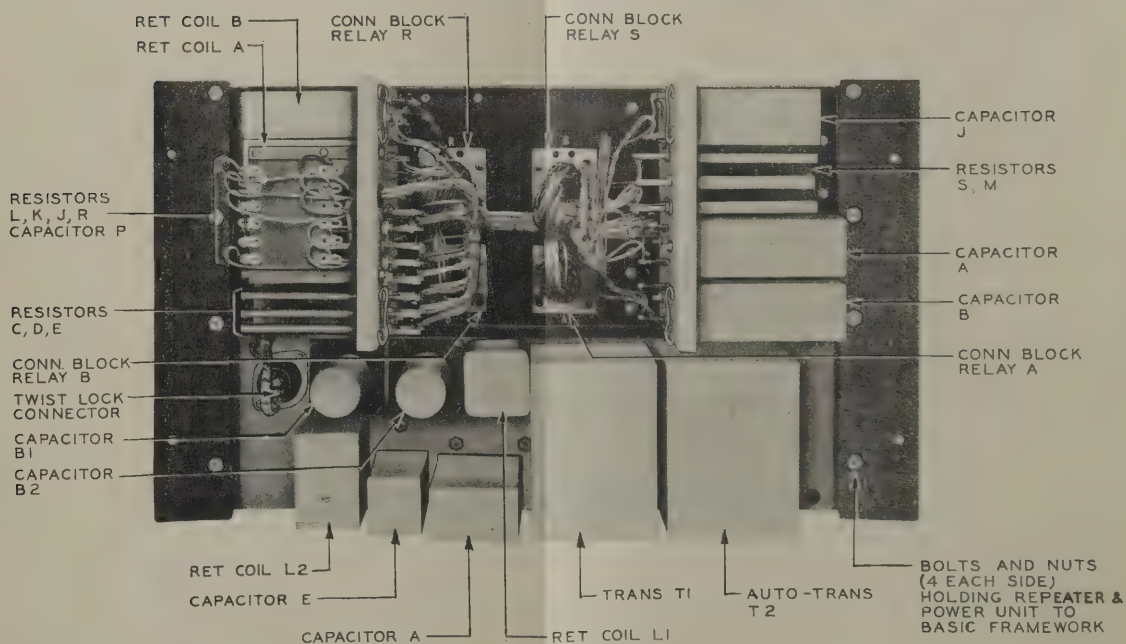


Figure 13 - Repeater TG-31 (Intermediate), rear view

OPERATING INSTRUCTIONS. REPEATER TG-31 (INTERMEDIATE)

LINE-UP PROCEDURE

- | OPERATION | READ PARAGRAPH |
|---|----------------|
| 1st CONNECT GROUND WIRE | 1 |
| 2nd CONNECT LINE WIRES | 2 |
| 3rd CONNECT PRINTER (AC OR GAS-ENGINE ONLY) | 3 |
| 4th THROW POWER SWITCHES | 4 |
| 5th CONNECT POWER CORD OR BATTERY LEADS | 5 |
| 6th ADJUST VOLTAGE | 6 |
- Connect ground wire to GND binding post (1) .
 - Connect line wire to distant Terminal A to LINE A binding post (4) .
Connect line wire to distant Terminal B to LINE B binding post (5) .
 - Printer TG-7-() .—Connect red plug to PRINTER RED R jack (2) . Connect black plug to PRINTER BLK S jack (3) . Connect printer power cord to PRINTER POWER receptacle (8) .
 - 115-volt A-c Power Supply.—Open panel (13) . Throw switch (14) to 115/230V AC and throw switch (15) to 115V AC. Throw power switch (11) to 115V or 230V AC OR 12V DC position.
 - 230-volt A-c Power Supply.—Open panel (13) . Throw switch (14) to 115/230V AC and throw switch (15) to 230V AC. Throw power switch (11) to 115V or 230V AC OR 12V DC position.
 - 12-volt D-c Power Supply (Storage Batteries).—Open panel (13) . Throw switch (14) to 12V STORAGE BAT position and throw power switch (11) to 115V or 230V AC OR 12V DC position.
 - 115-volt D-c Power Supply (Gas Engine or Dry Batteries).—Throw power switch (11) to 115V DC position.
 - With 115 Volts or 230 Volts A-c or 115 Volts D-c (gas engine).—Connect power cord (9) to power supply.
 - With 12-volt Storage Batteries.—Connect + and - battery leads to 12V STORAGE BAT binding posts (12) . Use No. 14 wire and not more than 4 feet for each lead.
 - With 115-volt Dry Batteries.—Connect + and - battery leads to 115V DRY BAT binding posts (10) . Three 45-volt batteries in series may be used.
 - With 115 or 230 Volts A-c or 12-volt Storage Batteries.—Hold down MEAS VOLTS key (6) and turn ADJUST VOLTS knobs (16) until meter reads 115V if printer is connected or 127V without printer.
 - With 115 Volts D-c (Gas Engine).—Hold down MEAS VOLTS key and adjust voltage at the source so that REPEATER TG-31 meter reads 115V.
 - With 115 Volts Dry Batteries.—Hold down MEAS VOLTS key and check voltage. Three new "B" batteries will give at least 135 volts.

SERVICE MAINTENANCE

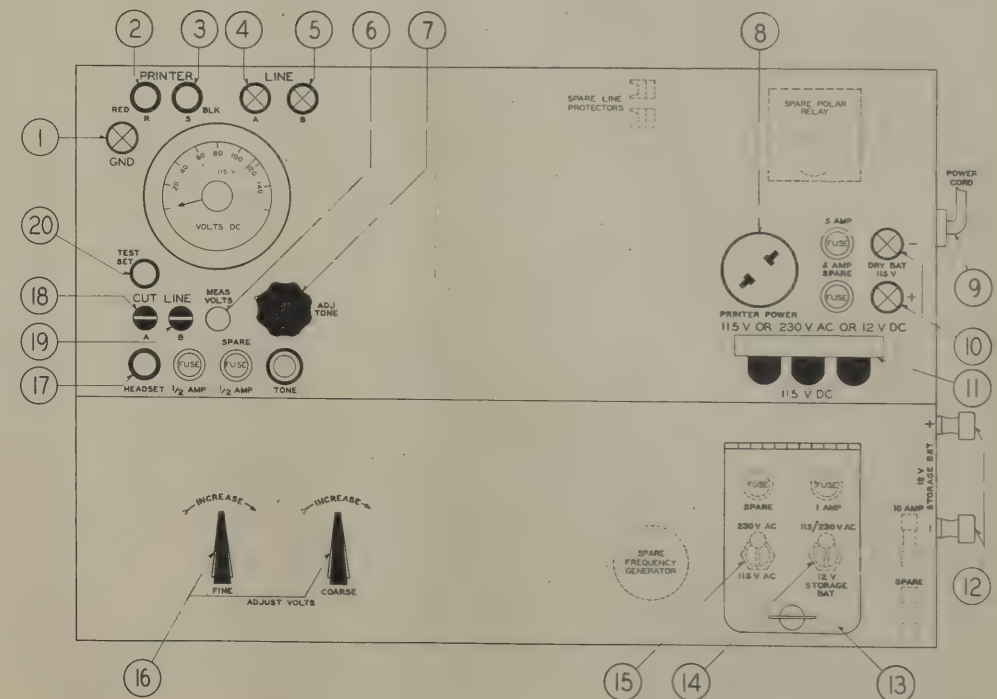
Maintain voltage as specified in par. 6a and 6b for 115 or 230 volts a-c, 12-volt storage batteries or 115 volts d-c (gas engine).
Replace storage batteries when unable to obtain 115V with ADJUST VOLTS knobs COARSE and FINE in extreme left position.
Replace dry batteries when voltage drops to 105 volts.

MISCELLANEOUS

Cutting Repeater.—If LINE A is out of service, turn CUT LINE A key (18) and communicate with Terminal B. If LINE B is out of service, turn CUT LINE B key (19) and communicate with Terminal A. RESTORE CUT KEYS when lines are again ready for service.

Manual Telegraph Operation.—Remove all printer cords. Connect headset to HEADSET jack (17) . Turn ADJ TONE knob (7) to suit while operating telegraph key.

Polar Relay Testing.—Refer to Technical Manual.



PATENTED: 2133380-2143000-2237154. PATENTS APPLIED FOR.

Figure 14 - Operating instructions, Repeater TG-31 (Intermediate)

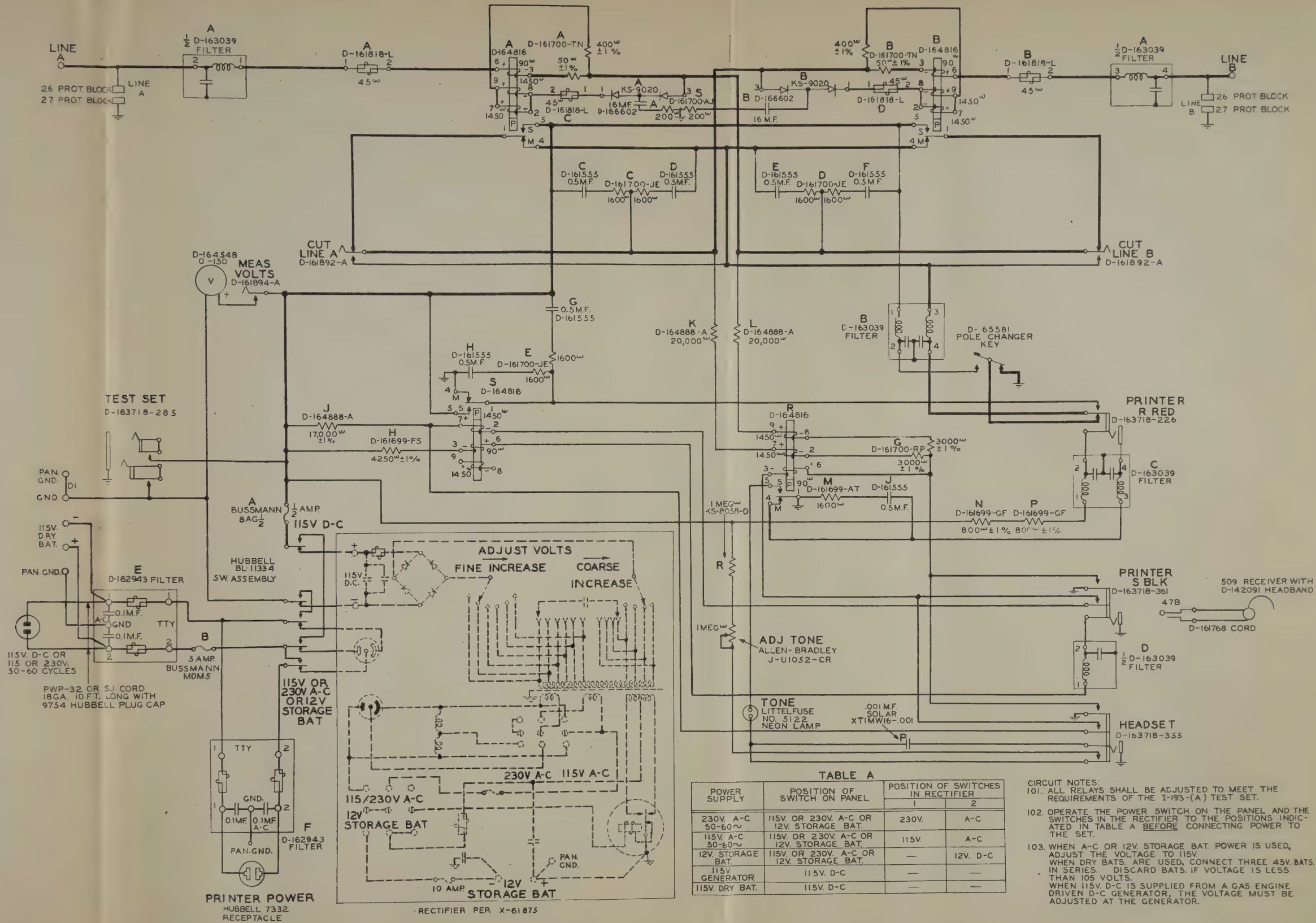
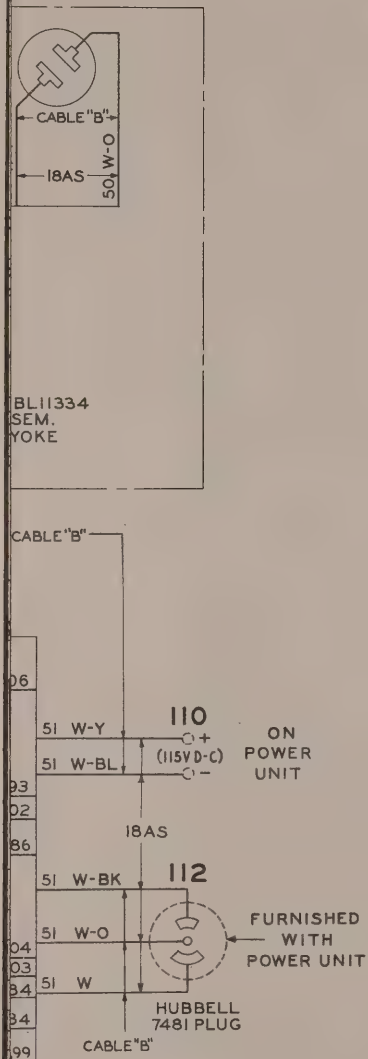


Figure 15 - Schematic circuit, repeater

NOTES:

1. WIRES NOT OTHERWISE SPECIFIED ARE 22AM.
 2. "B1" DENOTES EDGE OF RESISTANCE MOUNTING NEAREST TO SUBPANEL.
 3. "B2" DENOTES EDGE OF SUBPANEL NEAREST TO PANEL.
 4. "B3" DENOTES HINGED EDGE OF COVER.
 5. "PT" DENOTES LEADS FURNISHED AS PART OF APPARATUS.
 6. "J" TOP OF KEY LOOKING AT TERMINAL SIDE.
 7. "B4" DENOTES TERMINAL NEAREST TO PANEL.
- B. WIRES NOT OTHERWISE DESIGNATED RUN IN CABLE "A"

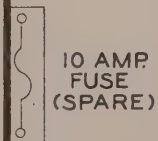
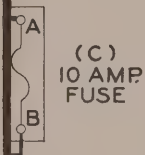


+ 10
 ○
 (115 V D-C)
 ○

NECT
 ER TEST
 PT

+ 19
 ○
 B.P.
 (12 V BAT)

—
 ○
 B.P.



NOTES:

1. WIRES NOT OTHERWISE SPECIFIED ARE 20AS STRANDED.
2. "D" WIRES ARE WHITE AND ARE NOT SEWED IN THE CABLE FORM BUT RUN PERPENDICULAR AND PARALLEL TO EDGES OF MOUNTING UNIT IN THE SHORTEST POSSIBLE MANNER.
3. "DI" WIRES ARE WHITE AND ARE RUN DIRECTLY FROM TERMINAL TO TERMINAL IN THE SHORTEST POSSIBLE MANNER AND INDEPENDENT OF ALL OTHER LEADS.
4. "PT" LEADS ARE FURNISHED AS PART OF APPARATUS.
6. CONNECTED TO TERMINALS OF (T1) TRANSFORMER IN ACCORDANCE WITH SHOP TEST.

